United States Air Force
611th Air Support Group/
Civil Engineering Squadron

Elmendorf AFB, Alaska

Final

Remedial Investigation and Feasiblity Study

Cape Lisburne Radar Installation, Alaska

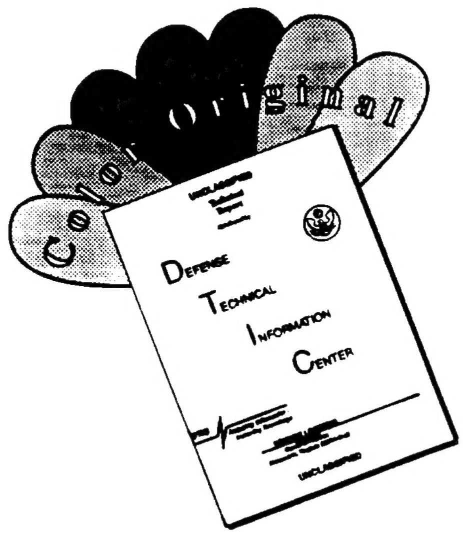
Volume 1 of 2
(Includes Appendices A through B)

Prepared by:

ICF Technology Incorporated

05 FEBRUARY 1996

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF COLOR PAGES WHICH DO NOT REPRODUCE LEGIBLY ON BLACK AND WHITE MICROFICHE.

PREFACE

This report presents the findings of Remedial Investigations and Feasiblity Studies at sites located at the Cape Lisburne radar installation in northern Alaska. The sites were characterized based on sampling and analyses conducted during Remedial Investigation activities performed during August and September 1993. This report was prepared by ICF Technology Incorporated.

This report was prepared between January 1995 and February 1996. Mr. Samer Karmi of the Air Force Center for Environmental Excellence was the Alaska Restoration Team Chief for this task. Dr. Jerome Madden and Mr. Richard Borsetti of the 611th CES/CEVR were the Remedial Project Managers for the project.

Approved:

____

Thomas McKinney
Program Director
ICF Technology Incorporated

NOTICE

This report has been prepared for the United States Air Force (USAF) by ICF Technology Incorporated for the purpose of aiding in the implementation of final remedial actions under the Air Force Installation Restoration Program (IRP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate. Acceptance does not mean that the United States Air Force adopts the conclusions, recommendations or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the United States Air Force.

Government agencies and their contractors registered with the Defense Technical Information Center (DTIC) should direct requests for copies of this report to: DTIC, Cameron Station, Alexandria, Virginia 22304-6145.

Non-Government agencies may purchase copies of this document from: National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

APPENDICES

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

BACKGROUND

The United States Air Force (Air Force) has prepared this Remedial Investigation/Feasibility Study (RI/FS) report as part of the Installation Restoration Program (IRP) to present results of the RI/FS activities at the five sites and one area of concern at the Cape Lisburne radar installation. The IRP provides for investigating, quantifying, and remediating environmental contamination from past waste management activities at Air Force installations throughout the United States. The IRP is a four-phase program that approximates the remedial investigation (RI) and corrective action program used by the U.S. Environmental Protection Agency (EPA) for addressing contaminated sites that may pose a risk to human health or the environment.

An Air Force contractor conducted Phase I Installation Assessment/Records Search activities at the Cape Lisburne installation and seven other northern installation (Engineering-Science 1995). Phase I activities included field inspection, reviews of installation and Alaskan Air Command (AAC) records and files, interviews with installation personnel, and evaluations using the Hazard Assessment Rating Methodology (HARM) system. The Phase I report makes recommendations for Phase II and other IRP activities, including field investigations. The Phase I report describes six geographical areas of potential concern due to industrial waste disposal, fuel spills, and other issues. The report indicated that further investigation was warranted at all six sites.

An Air Force contractor released the final Technical Support Document for Record of Decision, Cape Lisburne radar installation in 1988 (Woodward-Clyde 1988). The Record of Decision, applicable to six potential hazardous waste sites identified at the Cape Lisburne installation, called for no further action with regard to investigation or cleanup, based on the assessment that there is no significant impact on human health or the environment from suspected or confirmed past contamination.

A draft Site Investigation Report, Cape Lisburne Long Range Radar Station, Alaska, was released in 1992 (Woodward-Clyde 1992). The site investigation was conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (Superfund) program. EPA's estimated Hazard Ranking System (HRS) score for Cape Lisburne, based on a preliminary assessment, was sufficiently high to warrant further investigation.

The Air Force initiated Remedial Investigation/Feasibility Study (RI/FS) activities at the Cape Lisburne radar installation in the summer of 1993. During the initial scoping activities, which included record searches, personnel interviews, and physical inspection of the installation, the Air Force and Alaska Department of Environmental Conservation (ADEC) personnel concluded that five sites warranted investigation under the IRP. In addition, one area of concern (AOC) was also investigation to confirm that contaminants were not present.

RI/FS analytical results prompted the Air Force to initiate Interim Remedial Actions (IRA) at two of the sites at the Cape Lisburne installation. IRA activities were conducted at the Landfill and Waste Accumulation Area (LF01) and Spill/Leak #3 (ST07) during September 1994, May 1995,

and June 1995. A complete description of all IRA activities conducted at Cape Lisburne is presented in the Interim Remedial Action Report (U.S. Air Force 1995). Further characterization of the Cape Lisburne sites was conducted in conjunction with IRA activities.

This document is a detailed presentation of RI activities and provides conclusions and recommendations for addressing environmental conditions at the five sites and one area of concern at the Cape Lisburne radar installation.

INSTALLATION DESCRIPTION

The Cape Lisburne radar installation consists of 1,125 acres of land along the shore of the Chukchi Sea and within the Alaska Maritime National Wildlife Refuge (AMNWR). The installation is located approximately 810 miles northwest of Anchorage and 570 miles northwest of Fairbanks, respectively (see Figures 1-1 and 1-2, pages 1-5 and 1-7, respectively).

The facility was one of the 31 original White Alice Communications Systems (WACS) built to establish an air defense system in Alaska. It was constructed in 1952 and 1953. The WACS began operation in August 1957. The WACS was deactivated in 1979 and replaced with a satellite earth terminal. Currently, four contract personnel at the installation operate and maintain a Long Range Radar system located at the Upper Camp. Buildings at the Cape Lisburne installation are of traditional construction style. Support facilities in the Lower Camp include living quarters, a garage, a warehouse, inactive structures, and a 5,009-foot long runway.

The mean annual temperature is 18°F. Precipitation at Cape Lisburne averages 12.3 inches per year. Permafrost at the installation area is up to 1,330 feet thick.

The hydrology of the station is controlled by the sloping terrain and permafrost. The tundra is moist at lower elevations and is alpine tundra in higher elevations. Drainage is accomplished by suprapermafrost overland flow to diversion channels terminating at the Chukchi Sea.

Cape Lisburne is located at the west end of the Brooks Range. Bedrock found at the installation is comprised of sandstone, chert, shale, and conglomerates of the Shublik formation (U.S. Department of Interior 1988). The surface deposits of the Lower Camp area are up to 50 feet thick and are dominated by highly permeable talus and alluvial fan deposits consisting of clay, silt, sand, gravel, cobbles, and large boulders. A moderately well-sorted alluvium has been deposited in the channel of Selin Creek. The Upper Camp geology consists of a thin, gravelly layer overlying bedrock; this is typical of the steeper slopes.

The habitat types at Cape Lisburne support a variety of wildlife. Areas in the vicinity of the installation provides an important habitat to birds, mammals, and fish.

PROJECT ACTIVITIES

The Air Force conducted RI/FS field activities at five sites and one area of concern at the Cape Lisburne radar installation during 1993. The objectives of the Cape Lisburne RI/FS are to confirm the presence or absence of chemical contamination of the environment at the installation; define

the extent and magnitude of confirmed chemical releases; gather adequate data to determine the magnitude of potential risks to human health and the environment; and gather adequate data to identify and select the appropriate remedial actions for sites where apparent risks exceed acceptable limits. In addition, one area of concern (AOC) was investigated.

The RI field activities were carried out using a three-phase approach. The three phases, installation presurvey, reconnaissance, and RI field activities, allowed contractor personnel to confirm the location of areas of environmental concern and identify sampling location before conducting RI field activities. Five sites and the one AOC investigated during the RI activities include:

- Landfill and Waste Accumulation Area (LF01)
- White Alice Site (SS03)
- Spill/Leak #3 (ST07)
- Upper Camp Transformer Building (SS08)
- Lower Camp Transformer Buildings (SS09)
- Water Gallery (AOC3)

The site locations are shown in Figure 1-3 (page 1-9).

The RI field activities were conducted from mid-August through early September of 1993. In addition, further site characterization samples were collected and analyzed in conjunction with IRA activities in September 1994, May 1995, and June 1995. The RI was conducted in conjunction with RIs at seven other Air Force installations located throughout northern Alaska. Sixteen contractor employees were stationed in Alaska for the duration of the RI. Sampling activities at the Cape Lisburne radar installation included collection of surface and subsurface soil samples with hand tools and collection of surface water, sediment, and seep samples from drainages adjacent to potentially contaminated areas.

A total of 181 samples was collected during the RI activities at Cape Lisburne. These included soil, sediment, and surface water samples collected from the five sites and the one AOC as well as samples for Quality Assurance/Quality Control (QA/QC) and to establish background levels. A summary of the samples collected is presented in Table ES-1.

Analyses of samples collected during RI activities were conducted by a fixed laboratory in Anchorage, Alaska, and a temporary laboratory set up at Barrow, Alaska. Laboratory analyses conducted by the temporary laboratory were conducted on a quick turnaround basis. Analyses conducted in Anchorage, Alaska, included primarily standard turnaround but also a few quick turnaround analyses.

The Air Force conducted a risk assessment once the data had been validated and compiled. The purpose of the risk assessment was to evaluate the human and ecological health risks that may be associated with chemicals released to the environment at the sites investigated during the RI. The risk assessment characterizes the probability that measured concentrations of hazardous chemical substances will cause adverse effects in humans or the environment in the

TABLE ES-1. SUMMARY OF CAPE LISBURNE REMEDIAL INVESTIGATION SAMPLING

SITE	MEDIUM	NUMBER OF ENVIRONMENTAL SAMPLES
Background (BKGD)	Soil/Sediment	12
	Surface Water	2
Landfill and Waste Accumulation Area (LF01)	Soil/Sediment	47
	Surface Water	8
White Alice Site (SS03)	Soil/Sediment	16
Spill/Leak #3 (ST07)	Soil/Sediment	36
	Surface Water	2
Upper Camp Transformer Building (SS08)	Soil/Sediment	8
Lower Camp Transformer Buildings (SS09)	Soil/Sediment	13
Water Gallery (AOC3)	Surface Water	1
	Ground Water	4
Total Environmental Samples	Soil/Sediment	132
	Surface/Ground Water	17
QA/QC SAMPLES		
Ambient Condition Blanks	Water	2
Equipment Blanks	Water	9
Trip Blanks	Water	10
Replicates/Duplicates	Soil/Sediment	8
	Surface Water	3
Total Samples	Soil/Sediment	140
	Surface and Ground Water	41

absence of remediation. The risk assessment will be used in conjunction with state and federal standards and/or guidance to determine if remediation (site cleanup) is necessary

CHRONOLOGY OF ACTIVITIES

Project scoping documents were submitted between June and August 1993 for review by Air Force Center for Environmental Excellence (AFCEE) and regulatory agencies. These documents include the Work Plan, Sampling and Analysis Plan (SAP), Health and Safety Plan, and Community Relations Plan for seven DEW Line installations and Cape Lisburne. The installation Presurvey and the Reconnaissance trips were conducted in order to provide the information necessary to conduct the RI/FS activities. The Presurvey was conducted in May 1993 by a small group of contractor employees accompanied by Air Force representatives.

The Reconnaissance trip was completed in June 1993 by contractor employees, and the Air Force Center for Environmental Excellence (AFCEE) and ADEC representatives. RI field activities were conducted from mid-August through early September 1993. Further characterization samples were collected in conjunction with IRA activities during September 1994, May 1995, and June 1995. Sampling was conducted from the areas of least contamination to areas of increasing contamination. The sequence of sampling from least to most contaminated was based on previous sampling data, field screening, and visual observations. Field screening was used to assist in determining the areal extent of contamination and sampling locations. Where quick turnaround sample analyses indicated information gaps about the areal extent of contamination, or exposure point concentrations for potentially exposed populations were not defined, additional rounds of samples were collected and analyzed.

IRA activities were conducted at the Cape Lisburne radar installation during September 1994, May 1995, and June 1995. The activities conducted included the excavation and containment of drums, soil, and liquids from the buried Drum Area located within the Landfill and Waste Accumulation Area, site LF01, and the construction of a water collection and treatment system at Spill/Leak #3, site ST07. In conjunction with the IRA activities, additional samples were collected to further characterize the sites. The IRA Report and Cape Lisburne Risk Assessment were submitted under separate covers (U.S. Air Force 1995, 1996).

SUMMARY OF REMEDIAL INVESTIGATION/FEASIBILITY STUDY

The following paragraphs describe RI activities conducted at the five sites and one AOC that are the focus of this report and summarize the findings of the RI. Summaries of human health and ecological risks posed by chemicals detected at each site are included. The remedial alternatives are presented for the sites recommended for cleanup; however, the recommended remedial alternatives presented throughout the report shall be viewed as a general approach rather than a specific action because there are uncertainties regarding the effectiveness of the remedial alternatives in the unusual environment of the North Slope, future land use, and availability and timing of funding to perform remedial actions. As a result, the recommended alternatives identified in this report should not be considered the final word. Instead, they should be considered the best available approach pending treatability testing and remedial design. The

actual remedial action implemented may differ from those recommended in this report as more information and technological advances become available. The evaluation of remedial alternatives is presented in the Feasibility Study (FS), Section 5.0 of this report.

Landfill and Waste Accumulation Area (LF01). The Landfill and Waste Accumulation Area (LF01) site consists of three contiguous areas east of the runway and adjacent to the Chukchi Sea (Figure 1-3, page 1-9). The site is covered by gravel on the east and tundra on the west. Two small gravel areas (gravel covered areas #1 and #2) are located in the middle of the tundra-covered section adjacent to the road, and north of the beacon facility. The site was reportedly used to store waste oils, paints, solvents and diesel fuels, empty drums, discarded vehicles, and scrap metal. In 1977 to 1978 a general cleanup was performed, which included burial of empty drums and other debris, and off-site shipment of drums containing liquid wastes.

RI sampling and analyses detected volatile organic compounds (VOCs), benzene, toluene, ethylbenzene, and xylene (BTEX), gasoline range petroleum hydrocarbons (GRPH), diesel range petroleum hydrocarbons (DRPH), and residual range petroleum hydrocarbons (RRPH); concentrations of BTEX, DRPH, and RRPH were above action levels. A sludge pile/buried drum area was identified during the RI on the west side of the landfill, approximately 50 feet north of the gravel road. The sludge pile/buried drum area covered approximately 200 square feet. Sampling and analyses during the RI indicated that contaminants were migrating from this area towards the Chukchi Sea. The sludge pile/buried drum area was excavated as part of interim remedial actions (IRA) in May 1995. Excavated materials are temporarily stored in an onsite containment cell. Sampling and analyses conducted on soils from the sludge pile/buried drum area and containment cell are discussed in the Cape Lisburne IRA Report (U.S. Air Force 1995).

Sampling and analyses have determined that the Landfill and Waste Accumulation Area (LF01) site is contaminated with petroleum hydrocarbons, polychlorinated biphenyls (PCBs), and VOCs. The affected areas at the site are primarily gravel covered areas #1 and #2 and the excavated sludge pile/buried drum area, which was placed in the containment cell.

Migration of contaminants from the site appears to have occurred to a limited degree through drainage pathways that lead from these areas north to the Chukchi Sea. Relatively low levels of petroleum hydrocarbons, VOCs, and semi-volatile organic compounds (SVOCs) were detected in soil/sediment and surface water samples collected from the drainage pathways leading from these areas.

The risk assessment concluded that there is a potential risk posed to human health and ecological receptors by site contaminants, given current site uses and under a future scenario. This risk is of a magnitude that normally requires remedial action (EPA 1991b). In addition, levels of petroleum compounds (primarily residual oils) and PCBs detected at the site significantly exceed ADEC guidance cleanup levels, and migration of contaminants has occurred. Therefore, under current site conditions and considering the findings of the risk assessment, remediation of the site is recommended.

Offsite treatment/disposal is recommended as the alternative for remediation of the affected areas at the site (gravel covered areas #1 and #2 and soils in the containment cell). A complete

description and evaluation of the remedial alternatives considered for this site and the rational for the selected alternatives are presented in the FS, Section 5.0.

White Alice Site (SS03). This site is a communications site that was deactivated in 1979. It is located in the Upper Camp area on the southwest corner of the installation (Figure 1-3, page 1-9). The equipment and furniture were removed from the site in 1980, but the structures remain. The structures include an approximately 115 feet by 60 feet radio relay building and two large White Alice "billboards" that look like outdoor movie screens. The radio relay building once had transformers that contained PCB oils. It is suspected that dielectric fluids containing PCBs were discharged to the surrounding surface soils in small quantities during maintenance of the facility equipment.

Sampling and analyses have determined that the White Alice Site (SS03) is contaminated with Aroclor 1260, a group of PCBs. The contaminated areas at the site are in the soils around the doors to the White Alice building. The source of contamination is likely to be dielectric fluids containing PCBs that were suspected to have been discharged to the surrounding surface soils in small quantities during maintenance of the facility equipment. The site is deactivated, and the transformers have been removed from this site.

Migration of contaminants from the site appears to have been minimal. Affected gravel is limited to approximately 2,800 square feet around the building adjacent to the doorways. The potential for migration of PCBs is not anticipated as the site is relatively flat and PCBs tend to bind tightly with soil particles.

The risk assessment concluded that risks to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action (i.e., cancer risk $>1 \times 10^{-4}$ and noncancer risk that significantly exceeds one). Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore, the site is being recommended for remedial action. The contaminated area at the site consists of approximately 311 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the FS, Section 5.0.

Spill/Leak #3 (ST07). This site is located in the vicinity of the POL tanks, adjacent to the Arctic Ocean at the east end of the airstrip. The site consists of a bermed area around two POL tanks and the man-made hillside and drainage channel to the north (Figure 1-3, page 1-9). In August 1992 site personnel informed the ADEC that fuel had been observed seeping from the north hillside, downgradient from the POL tanks. Test pits were dug and approximately 25 gallons of fuel were collected. Leak tests were conducted and site personnel determined that the tanks were not leaking (ADEC 1992). Visual observation made during the RI at this location showed a few gallons of diesel product floating in an approximately 2-foot by 5-foot polyethylene plastic-

lined catchment area located at the base of the hillside north of the POL tanks. Oil absorbent booms have been laid across the drainage channel to collect diesel reaching the surface body. An interim remedial action (IRA) was conducted at this site during September 1994. An interception trench and collection and treatment system were installed to reduce the migration of diesel range petroleum from the hillside below the POL tanks to the drainage channel at the toe of the hill. The IRA activities at the site are discussed in detail in the Cape Lisburne IRA Report (U.S. Air Force 1995).

Sampling and analyses have determined that the Spill/Leak #3 (ST07) site is contaminated with petroleum hydrocarbons (DRPH) and volatile compounds, most of which are components of diesel fuel. The affected areas at the site include the bermed area adjacent to the POL tanks, the hillside north of the berm, and soils in the man-made drainage ditch.

The risk assessment concluded that risks posed to human health and ecological receptors by site contaminants are minimal given current or future site uses. The potential human health risks at the site are not of a magnitude that normally requires remedial action. The ecological risk assessment (ERA) concluded that the overall potential risks presented by site contaminants are minimal. Therefore, under current site conditions and considering the findings of the risk assessment, remediation of the site is not necessarily warranted.

Levels of petroleum compounds (primarily diesel) detected in soil/sediment at the site exceed ADEC guidance cleanup levels. In addition, site contaminants have migrated downgradient of the site and have impacted gravel areas. Therefore, the site is being recommended for remedial action. The remedial action alternative recommended for the site is enhanced bioremediation. This is in addition to the interception trench and collection and treatment system which was installed in 1994. A complete description and evaluation of the remedial alternatives considered for this site are presented in the FS, Section 5.0, and a complete description of the IRA activities conducted is presented in the IRA Report (U.S. Air Force 1995).

Upper Camp Transformer Building (SS08). The Upper Camp Transformer Building (SS08) site consists of a small abandoned building that previously housed electrical transformers. This site is located approximately 30 feet northeast of the radome in the Upper Camp (Figure 1-3, page 1-9). The site consists of an approximately 35 feet by 45 feet building placed on a gravel pad and bedrock. The building has a gravel floor with a concrete pad in the center. The transformers have been removed from the building; however, staining is apparent on the concrete pad and on the adjacent gravel within the building.

Sampling and analyses have determined that the Upper Camp Transformer Building (SS08) site is contaminated with DRPH, RRPH, and PCBs (Aroclors 1254 and 1260). The contaminated areas at the site are in the gravel area adjacent to the concrete pad on which a transformer was previously located. The likely source of contamination is previous spills and/or leaks of transformer fluid. The transformer and equipment was removed from the building when it was deactivated.

Migration of contaminants from the site appears to have been minimal. Contaminated gravel is limited to approximately 250 square feet within the building to the north and east of the concrete

transformer pad. The potential for migration of contaminants is not anticipated as the site is relatively flat, PCBs are relatively insoluble and tend to bind tightly with soil particles, and the area is enclosed in a building where there is minimal surface or subsurface migration.

The risk assessment concluded that risks posed to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action (i.e., cancer risk is $>1 \times 10^{-4}$ and noncancer hazard is significantly >1 [EPA 1991b]). Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore, the site is being recommended for remedial action. The contaminated area at the site consists of approximately 28 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the FS, Section 5.0.

Lower Camp Transformer Buildings (SS09). This site is composed of two inactive transformer buildings placed on a gravel pad located approximately 100 feet northwest of the main composite building in the Lower Camp (Figure 1-3, page 1-9). Both buildings have a gravel floor with a concrete pad in the center. Staining is apparent on the concrete pads and on the adjacent soils in both buildings. Station personnel indicate that these buildings contained several PCB-bearing electrical transformers. The transformers have been removed from the building, but some support structures still remain.

Sampling and analyses have determined that the Lower Camp Transformer Buildings (SS09) site is contaminated DRPH, RRPH, and PCBs (Aroclors 1254 and 1260). The contaminated area at the site is the soil and gravel areas adjacent to the concrete pads on which the transformers were previously located. The likely source of contamination is former spills and/or leaks of transformer fluid. The transformers and equipment were removed from the buildings when the site was deactivated.

Migration of contaminants from the site appears to have been minimal. Contaminated gravel is limited to approximately 183 square feet adjacent to the concrete transformer pads. The potential for migration of contaminants is not anticipated as the site is relatively flat, PCBs are relatively insoluble and tend to bind tightly with soil particles, and the area is enclosed by buildings where there is minimal surface or subsurface migration.

The risk assessment concluded that risks to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action (i.e., cancer risk is $>1 \times 10^{-4}$ and noncancer hazard is significantly >1 [EPA 1991b]). Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore the site is being recommended for remedial action. The contaminated area at the site consists of approximately 20 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the FS, Section 5.0

Water Gallery (AOC3). The Water Gallery (AOC3) is located on Selin Creek, approximately 200 yards east of the main installation, and is the source from which the installation obtains drinking water (Figure 1-3, page 1-9). Selin Creek is a shallow, braided stream with a rocky bed; during the RI the stream contained clear water and had no vegetation in the stream bed. Shallow groundwater wells and a pumphouse are part of the Water Gallery system. The water supply system was investigated because trace amounts of carbon disulfide were reported in a previous water sample (Woodward-Clyde 1992). Sampling and analysis of the Water Gallery (AOC3) was conducted during the RI because the validity of the 1992 data and the presence of carbon disulfide in the water are questionable.

Sampling and analyses have determined that the Water Gallery (AOC3) is not contaminated. No chemicals were detected at the AOC, and the Water Gallery (AOC3) is recommended for no further action.

CONCLUSIONS

To meet the Air Force's commitment to identify, quantify, and remediate waste disposal sites at installations throughout the United States, the prime contractor completed an RI/FS at five sites and one AOC at the Cape Lisburne radar installation. The investigation was completed in accordance with the guidelines established in the Air Force's IRP.

Based on the RI sampling and data analyses, the Air Force has concluded there is no risk associated with observed conditions and recommends no further action for the one AOC, the Water Gallery (AOC3).

At the five sites, contaminant levels either may represent a potential risk to receptor populations and/or exceed ADEC cleanup guidance levels. It is recommended that remedial actions be conducted at these sites. These sites include the Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Spill/Leak #3 (ST07), Upper Camp Transformer Building (SS08), and the Lower Camp Transformer Buildings (SS09). The remedial action alternatives recommended for these five sites are presented in Table ES-2.

TABLE ES-2. SITES RECOMMENDED FOR REMEDIAL ACTION

SITE NAME	SITE ID NUMBER	MEDIUM	RECOMMENDED REMEDIAL ALTERNATIVE
Landfill and Waste Accumulation Area	LF01	Soil,Gravel, Drums, Liquid, and Debris	Offsite treatment/disposal
White Alice Site	SS03	Soil/Gravel	Offsite treatment/disposal
Spill/Leak #3	ST07	Soil/Gravel	Enhanced Bioremediation
Upper Camp Transformer Building	SS08	Soil/Gravel, Concrete Pad	Offsite treatment/disposal
Lower Camp Transformer Buildings	SS09	Soil/Gravel, Concrete Pad	Offsite treatment/disposal

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

The Air Force has prepared this RI/FS report to present the results of RI/FS activities at five sites and one AOC located at the Cape Lisburne radar installation. The RI field activities were conducted at the Cape Lisburne radar installation during the summer of 1993. The five sites and one AOC at Cape Lisburne were investigated because they were suspected of being contaminated with hazardous substances. The RI/FS was conducted in accordance with the requirements of the Air Force Installation Restoration Program (IRP). RI activities were conducted using methods and procedures specified in the RI/FS Work Plan, Sampling and Analysis Plan (SAP), and Health and Safety Plan (U.S. Air Force 1993a,b,c).

Section 1.0 of this report presents information concerning the objectives and implementation of the IRP, a description of the installation and its environmental setting at Cape Lisburne, and brief background information on the Cape Lisburne sites. Project activities, including project objectives and scope, summaries of field and laboratory methods, methodologies for data evaluation and risk estimation, and a summary of background sampling, analytical results, and migration pathways are described in Section 2.0. Section 3.0 documents the RI sampling and analysis results for the one AOC where no further action is recommended. Section 4.0 presents the RI sampling and analysis results on a site-by-site basis for the five sites where remedial actions may be warranted; identifies all Applicable or Relevant and Appropriate Requirements (ARARs); identifies potential migration pathways and receptors; summarizes human health and ecological risks; and describes the conclusions and recommendations, including the recommended remedial alternative, for cleanup at each site. Section 5.0 presents the Feasibility Study (FS) of potential remedial actions for the sites that may require cleanup.

The recommended actions for each of the sites, presented in Section 3.0 through 5.0, are preliminary. The actions for each site will be determined only after review of this RI/FS document and the Cape Lisburne Risk Assessment (U.S. Air Force 1996) by regulatory agencies and interested parties. When agreement is reached between the Air Force and regulatory agencies as to the appropriate action for each site, a Final Decision Document will be prepared by the Air Force that presents the rationale for selecting a particular action. The Decision Document will formally document the selection by ensuring appropriate Air Force and state and federal agency coordination and concurrence.

Appendix A provides references and a list of acronyms used in this document. Appendix B presents photographs of the Cape Lisburne radar installation and sites. Appendix C is the Statement of Work describing the scope of the RI/FS activities at the Cape Lisburne radar installation. Sample collection logs are presented in Appendix D; sample Chain-of-Custody forms are in Appendix E. Cross-reference tables and analytical data are presented in Appendix F, and data validation reports are in Appendix G.

1.1 THE UNITED STATES AIR FORCE INSTALLATION RESTORATION PROGRAM

The Air Force IRP is the basis for assessment and response action on Air Force installations under the provisions of the CERCLA. The Air Force IRP is designed to identify, confirm/quantify, and remedy problems associated with past and present management of hazardous substances and hazardous wastes at Air Force facilities. CERCLA defines a hazardous substance in Section 101; the definition includes, as examples, any substance designated pursuant to Section 311(b)(2)(A) of the Federal Water Pollution Control Act (FWPCA), any element, compound, mixture, solution, or substance designated pursuant to Section 102 of CERCLA, and hazardous wastes identified pursuant to Section 3001 of the Resource Conservation and Recovery Act (RCRA). A hazardous waste, as defined in RCRA, "may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of or otherwise managed" (Section 1004[2][B] of RCRA).

The Department of Defense (DOD) reinitiated the IRP in 1976 to identify, investigate, and mitigate environmental hazardous waste contamination that may be present at DOD facilities. In June 1980, DOD issued Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6, requiring identification of past hazardous waste disposal sites at DOD agency installations. The Air Force implemented DEQPPM 80-6 in December 1980 and revised it in 1981.

Executive Order 12316 of 6 August 1981 directed the military to design its own program to remedy uncontrolled hazardous waste disposal sites consistent with the National Contingency Plan (NCP) established by CERCLA. In response to the directive, the DOD instructed its branches to identify hazardous waste disposal sites to which they contributed wastes, and to comply with environmental regulations at the installation level when implementing cleanup. DOD subsequently developed the basic IRP after which the Air Force IRP was modeled. DEQPPM 81-5 of 11 December 1981, implemented by Air Force Headquarters in January 1982, sets forth the basic authority and objectives for the Air Force programs.

The Superfund Amendments and Reauthorization Act of 1986 (SARA) augmented the scope and requirements of CERCLA and provided specific directives to federal facilities regarding investigation of waste disposal sites. Under SARA, technologies that provide permanent removal or destruction of hazardous wastes or contaminants are preferable to actions that only contain or isolate the materials. SARA also provides for greater interaction with public and state agencies and expands the role of the EPA in the evaluation of the health risks associated with contamination. SARA requires early determination of ARARs and the consideration of potential remediation alternatives at the initiation of a RI/FS. Remedial actions taken under CERCLA must comply with ARARs, which generally consist of federal, state, and local regulations. Remedial actions at facilities regulated under CERCLA are selected based on the results of a RI/FS. The RI/FS process is described in the NCP. The RI phase includes specific steps for determining the nature and extent of environmental contamination. Subsequently, the FS is implemented to evaluate alternative remedial actions prior to selection of the most appropriate action for a specific facility.

To respond to changes in the NCP brought about by SARA, the Air Force modified its IRP in November 1986 to improve continuity in the site investigation and remedial planning process for

Air Force installations. In July 1987 the President signed Executive Order 12580, delegating responsibility to secretaries of various agencies to conduct site investigations and remedial actions at federal facilities. The order defined relationships between various federal and state agencies and assigned EPA the role of facilitator in resolving conflicts.

Prior to 1988 the Air Force IRP was organized into four phases, described below:

- Phase I, Installation Assessment/Records Search, identified past waste disposal sites at Air Force installations that might pose a hazard to public health or the environment. Sites identified during Phase I could be recommended for no further action, confirmation studies (Phase II), or remedial action (Phase IV).

- Phase II, Confirmation/Quantification, was intended to define and quantify contamination present at sites identified during Phase I. Stage 1 of Phase II consisted of an initial assessment, including environmental sampling, to determine whether contamination was present. Depending on the results of Stage 1, subsequent stages of investigation could be recommended to improve the characterization of site contamination.

- Phase III, Technology-Based Development, included development of new technologies for treating contaminants identified at Air Force installations. The results of Phase II investigations were used to determine the need for Phase III activities.

- Phase IV, Remedial Action, involved development and implementation of plans to remedy contamination at sites.

In 1988, the Air Force replaced the phased approach of the IRP with an approach more closely resembling the RI/FS approach used by EPA. Under this approach, Phase II investigations and Phase IV remedial action planning are conducted in a more parallel fashion to expedite implementation of site cleanups.

1.2 INSTALLATION DESCRIPTION AND ENVIRONMENTAL SETTING

The Cape Lisburne radar installation consists of 1,125 acres of land along the shore of the Chukchi Sea, within the AMNWR. The installation is located approximately 810 miles northwest of Anchorage and 570 miles northwest of Fairbanks.

The facility was one of the 31 original WACS built to establish an air defense system in Alaska. It was constructed in 1952 and 1953. The WACS began operation in August 1957. The WACS was deactivated in 1979 and replaced with a satellite earth terminal. Currently, four contract personnel at the installation operate and maintain an LRR system located at the Upper Camp. Buildings at the Cape Lisburne installation are of traditional construction style. Support facilities include living quarters, a garage, a warehouse, inactive structures, and a 5,009-foot long runway.

The general location of Cape Lisburne radar installation is shown on Figure 1-1. An area location map is presented in Figure 1-2, and a site plan is provided as Figure 1-3.

1.2.1 Physical Geography

The installation located at 68°52' N, 166°15' W, and is accessible only by sea or air. Radar equipment is located at the top of a mountain at the Upper Camp, and support facilities for all station operations are located at the Lower Camp near the coast. The two camps are connected by a 3.9-mile winding road. Point Hope is the nearest community, located 35 miles to the southwest. There is no road connecting Point Hope and the Cape Lisburne installation.

1.2.2 Climate (Meteorological Conditions and Air Quality)

At Cape Lisburne precipitation averages 12.3 inches per year. The mean annual temperature is 18°F. Prevailing winds are from the east and average 10 mph. There is very little annual variation; however, October and November winds are the strongest.

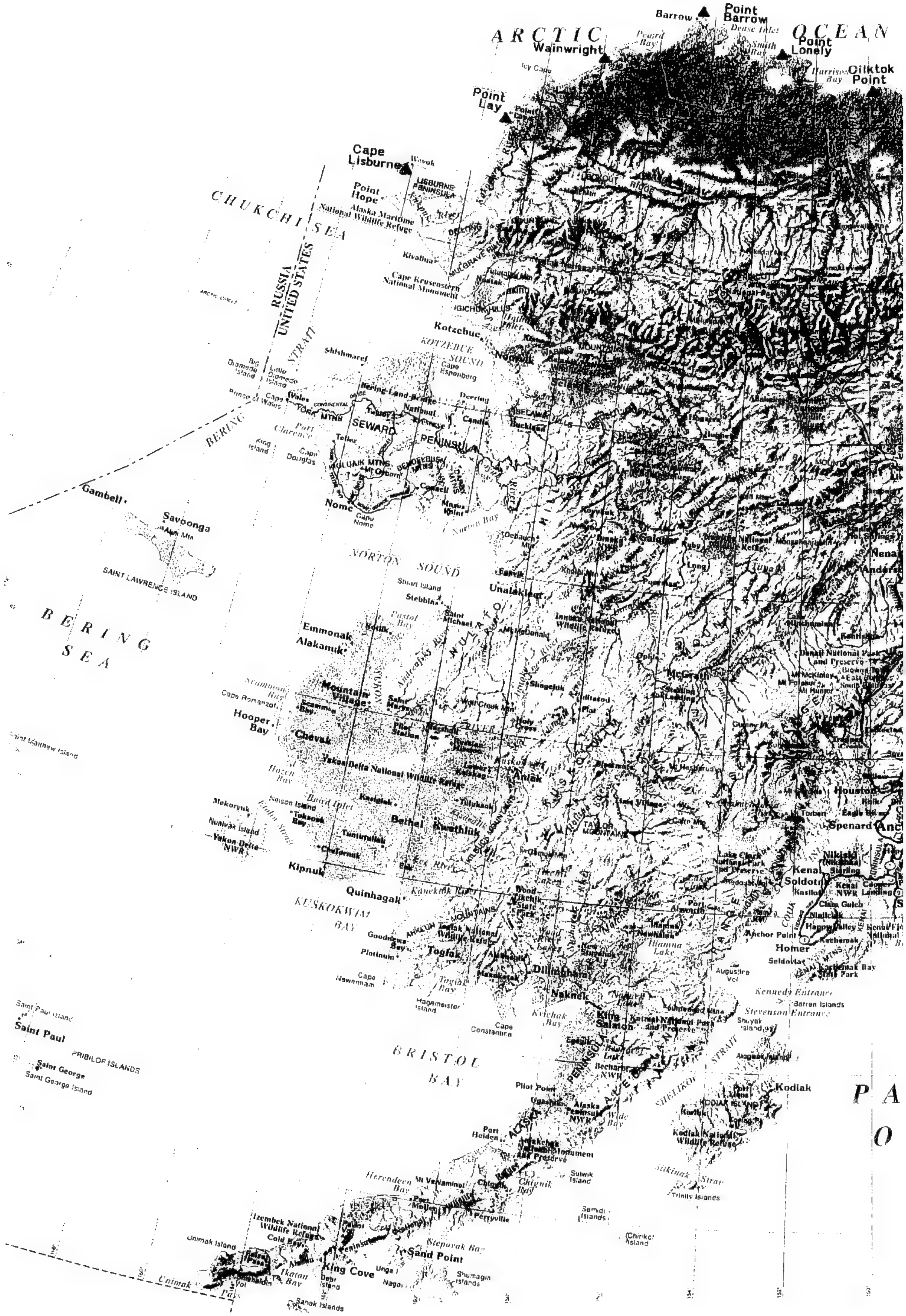
Air quality has not been measured at the Cape Lisburne installation, but is expected to be good because there are no major sources of air pollution. The persistent winds of the area ensure good ventilation and reduce the potential for significant air quality degradation.

1.2.3 Geology

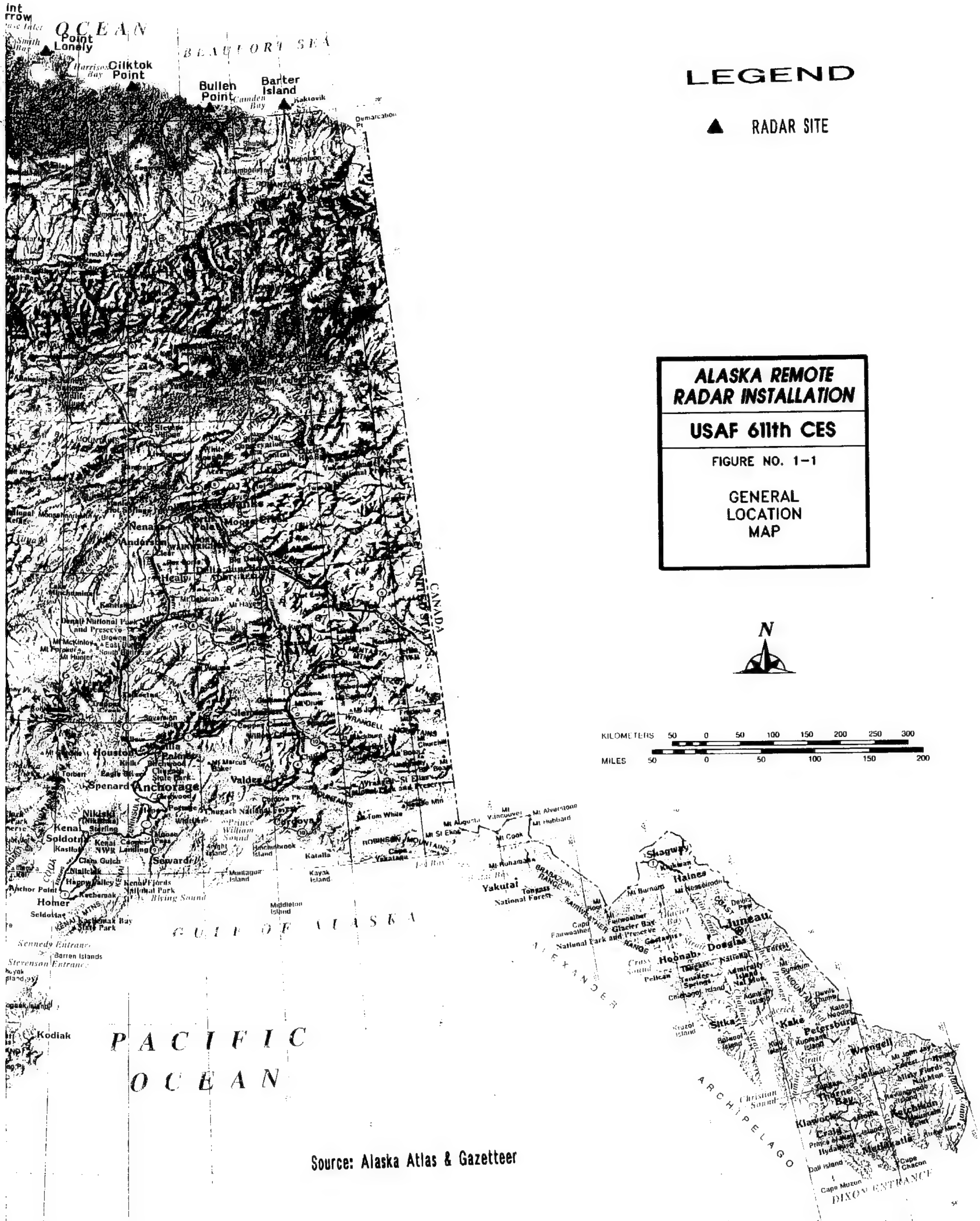
This section presents information on the regional and local geology of the Cape Lisburne area.

1.2.3.1 Regional Geology. Geologic units of all the principal time-stratigraphic systems from Precambrian to Quaternary are represented in Alaska. For the last two or three million years, frost climates have prevailed in Alaska and the geomorphic processes have been either periglacial or glacial (Wahrhaftig 1965). Although glacial activity was extensive, it was by no means all-encompassing. Glaciation is evident in many parts of the state including the Pacific Mountain System, Arctic Mountains, Ahklun Mountains, and southern Seaward Peninsula. Some great expanses, however, had no glacial activity. The principal areas not glaciated include the Intermountain Plateaus, Arctic Foothills, and Arctic Coastal Plain. Many periglacial features such as polygonal ground, sorted circles, pingos, and ice wedges can be observed on the Arctic Coastal Plain. Figure 1-4 depicts the extent of Alaska's glacial areas.

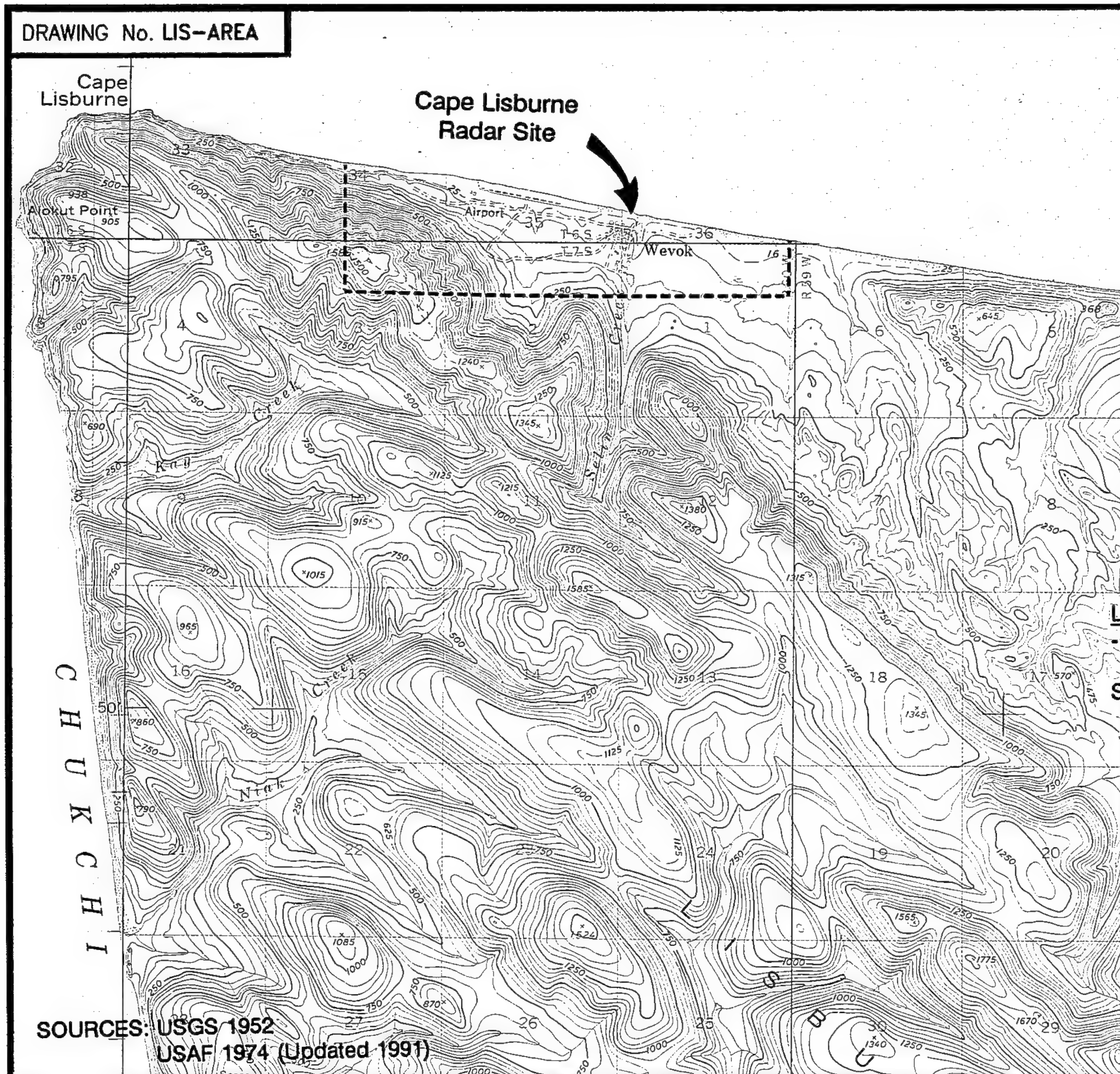
Alaska's generally cold climate regime has produced permafrost, a combination of geologic, hydrologic, and meteorologic characteristics that produces permanently frozen ground. Permafrost occurs in both unconsolidated sediments and bedrock; its distribution includes most of the state, with the notable exception of the Pacific Coastal area. Permafrost is continuous on the Arctic Coastal Plain and has a significant impact on the flow of ground and surface water. The distribution of Alaska's permafrost areas is shown on Figure 1-5. Permafrost is discussed in detail in Section 1.2.4.1.



ARCTIC
OCEAN
Barrow
Point Barrow
Wainwright
Point Lonely
Oliktok Point
Point Lay
Cape Lisburne
Point Hope
CHUKCHI SEA
LISBURNE PENINSULA
Alaska Maritime National Wildlife Refuge
Kivalina
Cape Krusenstern National Monument
RUSSIA
UNITED STATES
Kotzebue
KOTZEBUE SOUND
Shishmaref
Big Diomede Island
Little Diomede Island
Wales
Cape Prince of Wales
BERING STRAIT
Bering Land Bridge National Preserve
Deering
SEWARD PENINSULA
Teller
Port Clarence
King Island
Cape Douglas
Nome
Cape Nome
Gambell
Savoonga
SAINT LAWRENCE ISLAND
NORTON SOUND
Norton Bay
Stuart Island
Stebbins
Saint Michael
Unalakleet
Kaltag
Galena
McGrath
BERING SEA
Emmonak
Alakanuk
Mountain Village
Cape Romanzof
Hooper Bay
Chevak
Saint Matthew Island
Yukon Delta National Wildlife Refuge
Aniak
Mekoryuk
Nunivak Island
Yukon Delta NWR
Bethel
Kwethluk
Kipnuk
Quinhagak
KUSKOKWIM BAY
Goodnews Bay
Platinum
Togiak
Cape Newenham
Dillingham
Naknek
King Salmon
Hagemeister Island
Cape Constantine
BRISTOL BAY
Saint Paul Island
Saint Paul
PRIBILOF ISLANDS
Saint George
Saint George Island
Pilot Point
Port Heiden
ALASKA PENINSULA
Chignik
Perryville
Herendeen Bay
Izembek National Wildlife Refuge
Cold Bay
Unimak Island
Unimak Pass
King Cove
Sand Point
Sanak Islands
Shumagin Islands
Semidi Islands
Chirikof Island
Sutwik Island
Trinity Islands
Kodiak
KODIAK ISLAND
Kodiak National Wildlife Refuge
SHELIKOF STRAIT
Kenai
Soldotna
Homer
Seldovia
Anchor Point
Spenard
Houston
Augustine Vol
Kennedy Entrance
Barren Islands
Stevenson Entrance
Shuyak Island
Afognak Island
Iliamna Lake
Lake Clark National Park and Preserve
Katmai National Park and Preserve
Becharof Lake
Aniakchak National Monument and Preserve
Denali National Park and Preserve
Mt McKinley
PA
O



Source: Alaska Atlas & Gazetteer



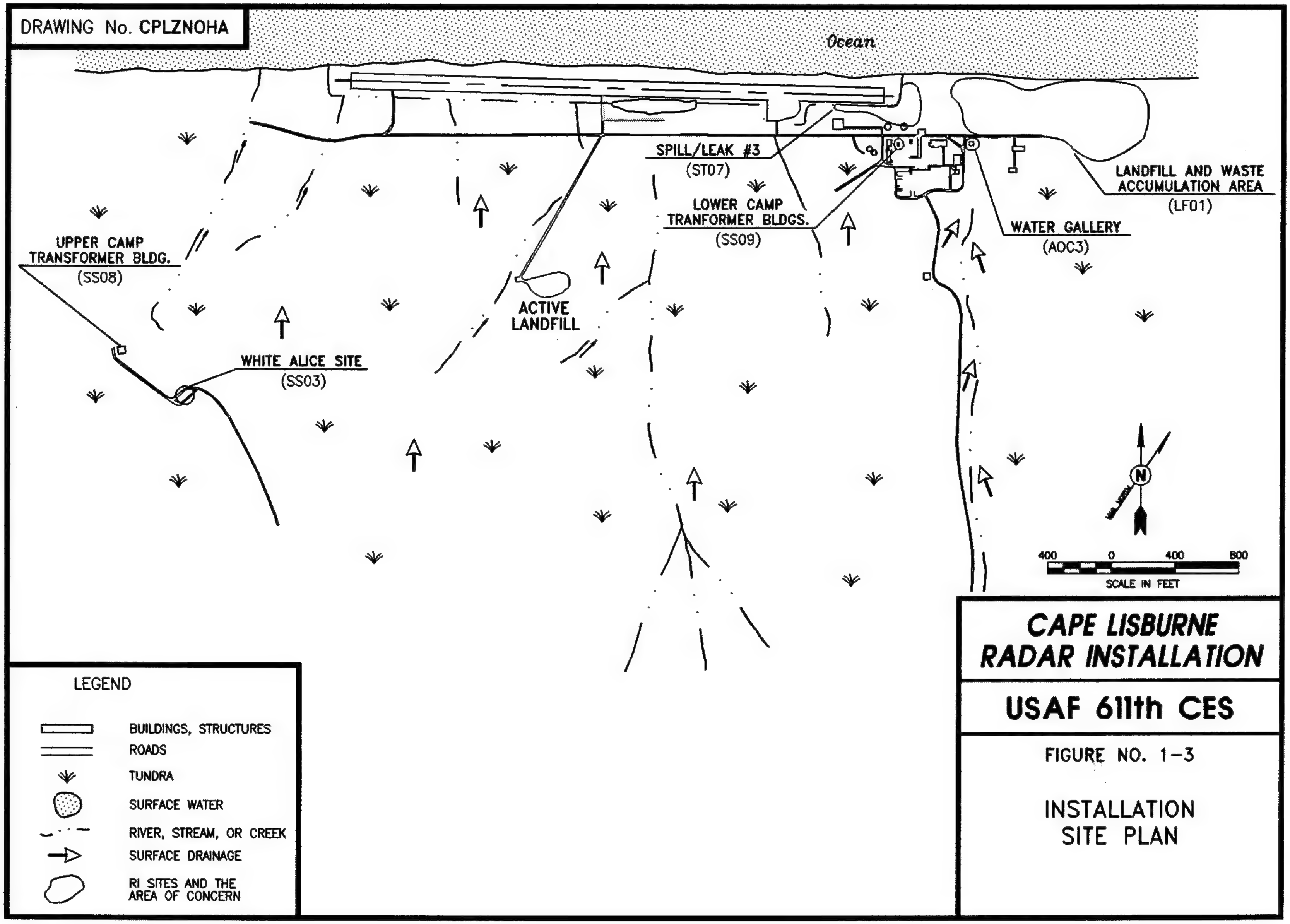
CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 1-2

AREA LOCATION MAP

THIS PAGE INTENTIONALLY LEFT BLANK



CAPE LISBURNE RADAR INSTALLATION

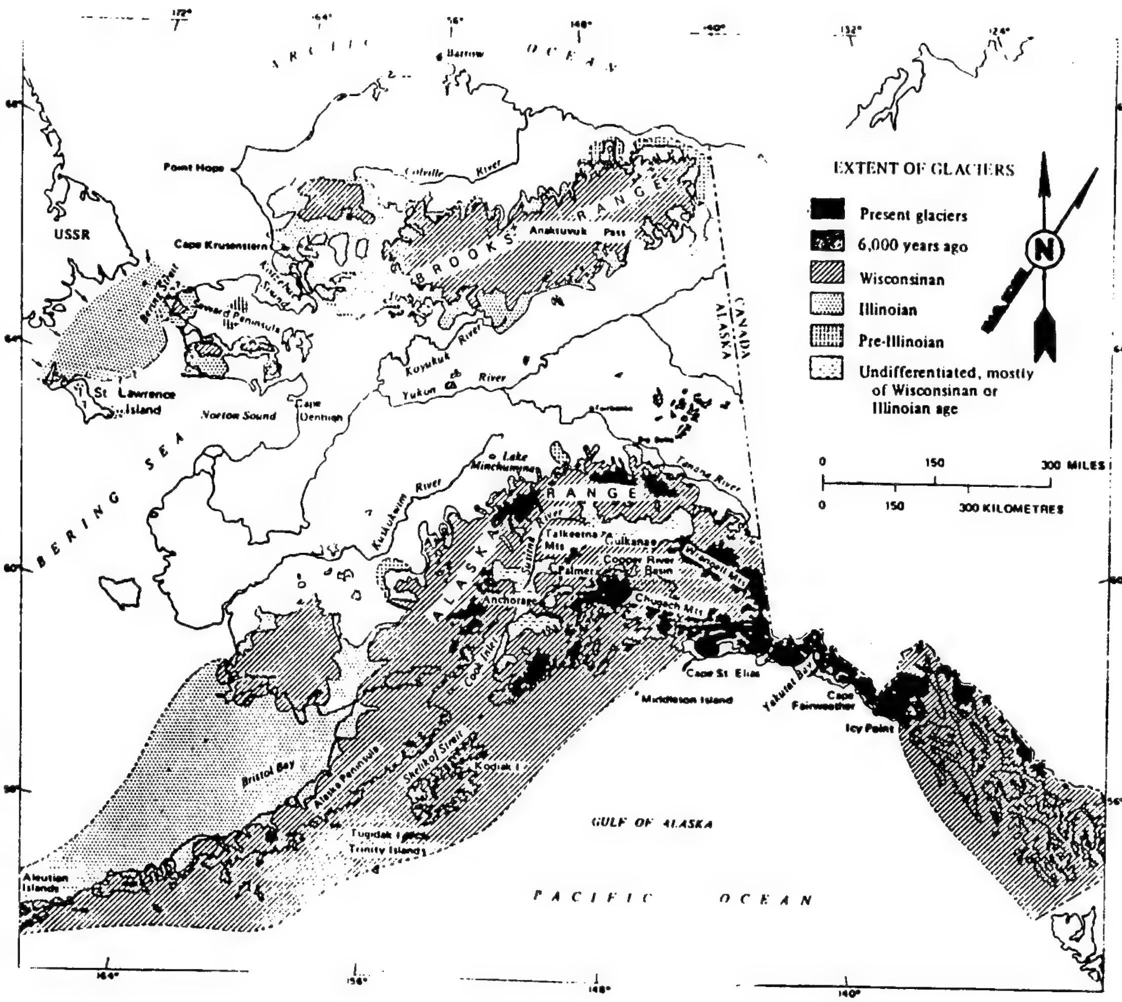
USAF 611th CES

FIGURE NO. 1-3

INSTALLATION SITE PLAN

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. LIS1-4



SOURCE: Pewe 1975

ALASKA REMOTE RADAR INSTALLATIONS

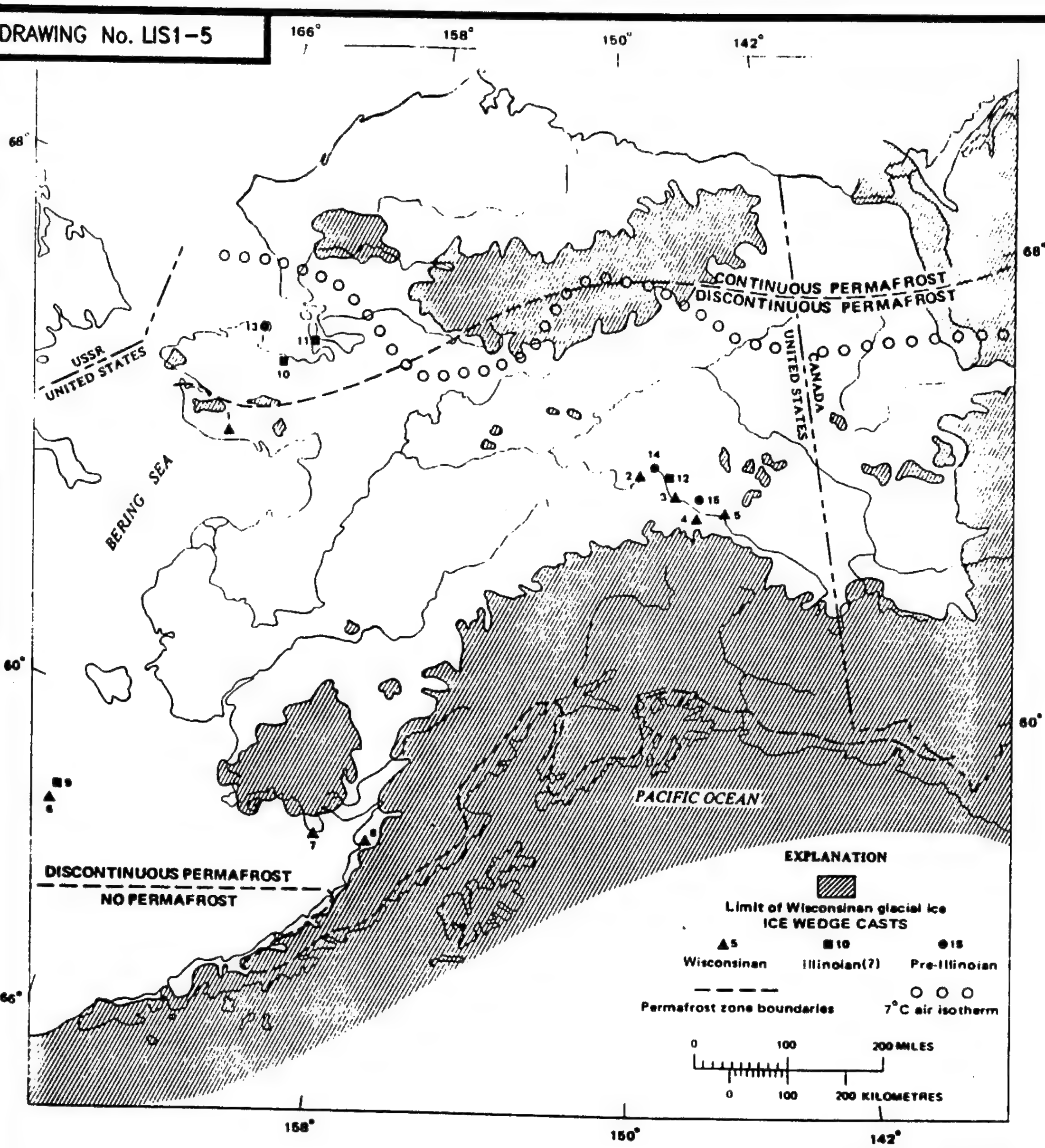
USAF 611th CES

FIGURE NO. 1-4

QUATERNARY GLACIATION IN ALASKA

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. LIS1-5



SOURCE: Pewe 1975

ALASKA REMOTE RADAR INSTALLATIONS

USAF 611th CES

FIGURE NO. 1-5

PERMAFROST MAP

THIS PAGE INTENTIONALLY LEFT BLANK

The very strong geologic processes at work in Alaska have produced a unique environmental setting reflected in the general geology of the Arctic Region (Figure 1-6). A popular theory of the formation of the Arctic Region is that it was once an ocean basin adjacent to the Canadian Shield. Rifting of the Canadian Shield occurred during Mesozoic time, and the Arctic Region drifted southwest forming the Colville Basin to the south and the Arctic Ocean to the north. At the same time, the Brooks Range orogeny began creating a source for the newly-created Colville Basin. Continued uplift of the Brooks Range produced a prograding delta that filled in the Colville Basin.

1.2.3.2 Local Geology. Bedrock found at the Cape Lisburne installation is comprised of sandstone, chert, shale, and conglomerates of the Shublik formation (U.S. Department of Interior 1988). The bedrock found two miles east of the cape, which consists of granite, schist, limestone, and gneiss, may contribute to the eroded fluvial and alluvial material found at the installation. The surficial Quaternary deposits are composed of coarse and fine-grained deposits associated with moderate to steep sloped mountains and hills. Bedrock exposures are mostly restricted to upper slopes, crestlines, and eroded areas (Engineering Science 1985).

The surface deposits of the Lower Camp area are up to 50 feet thick and are dominated by highly permeable talus and alluvial fan deposits consisting of clay, silt, sand, gravel, cobbles, and large boulders. A moderately well-sorted alluvium has been deposited in the channel of Selin Creek (Engineering Science 1985). The Upper Camp geology consists of a thin, gravelly layer overlying bedrock; this is typical of the steeper slopes (Engineering Science 1985).

The occurrence of permafrost is relatively continuous in the Cape Lisburne area and may reach maximum depths of 600 to 800 feet below grade in zones near large bodies of water. Farther inland, maximum permafrost depths may reach 1,330 feet (Engineering Science 1985).

1.2.4 Hydrology

Ground water/permafrost and surface water are discussed in the following sections.

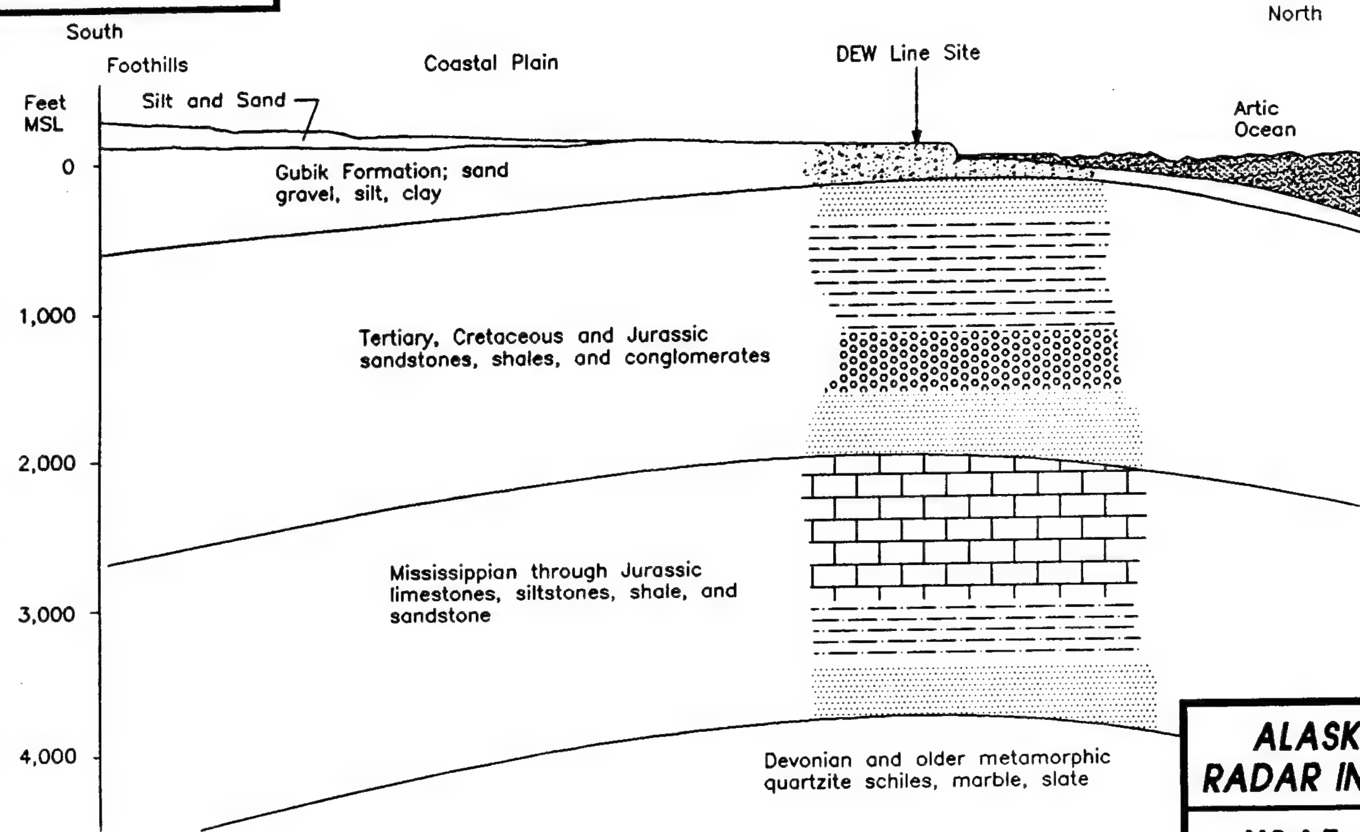
1.2.4.1 Ground Water/Permafrost. Permafrost has a profound influence on Alaska's ground water resources. Permafrost is defined by the Glossary of Geology (American Geological Institute 1972) as:

- Any soil, subsoil, or other surficial deposit, or even bedrock, occurring in arctic or subarctic regions at a variable depth beneath the earth's surface in which a temperature below freezing has existed continuously for a longtime (from two years to thousands of years). This definition is based exclusively on temperature and disregards the texture, degree of compaction, water content, and lithologic character of the material.

Permafrost has a major impact on the relationship between surface water and ground water in cold regions such as Alaska. Although ground water in permafrost regions follows the same geologic and hydrologic principles as in temperate areas, the hydrologic regime is modified in the following ways:

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. LAY1-6



SOURCE: CH2M HILL 1981

Not to Scale

ALASKA REMOTE RADAR INSTALLATIONS

USAF 611th CES

FIGURE NO. 1-6

GENERALIZED NORTH-SOUTH GEOLOGIC CROSS SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

- Permafrost acts as an impermeable barrier to the movement of ground water because pore spaces are ice-filled in the zone of saturation. Recharge and discharge are, therefore, limited to unfrozen channels penetrating the permafrost zone. The unfrozen channels are termed perforating taliks. Permafrost restricts the downward percolation of water and increases runoff, enhancing the creation of lakes and swamps (Feulner et al. 1971).

- Permafrost zones tend to reduce evapotranspiration. The generally low ground temperatures tend to reduce direct evaporation and transpiration (the escape of moisture through plant tissue into the air). Vegetative growth is enhanced near large surface water bodies where permafrost usually occurs at greater depth.

- Permafrost restricts an aquifer's storage capacity and the number of locations from which ground water may be withdrawn. Subpermafrost ground water occurs beneath the permafrost zone and is usually dependable. Suprapermafrost water occurs in the active zone, above the permafrost table, and tends to be seasonal; it freezes during the cold winter months.

- The ground water temperature varies from 32 to 40.1°F in permafrost regions because of the low ground temperatures (Williams 1970). Water tends to be more viscous in this temperature range and, therefore, moves slower than in temperate regions.

Low ground temperatures create the necessary environment for permafrost to form. The segment above the permafrost table is called the active zone, because it freezes and thaws with seasonal weather changes. The permafrost zone remains frozen year-round. The active zone is significant because suprapermafrost active zone water exists within it.

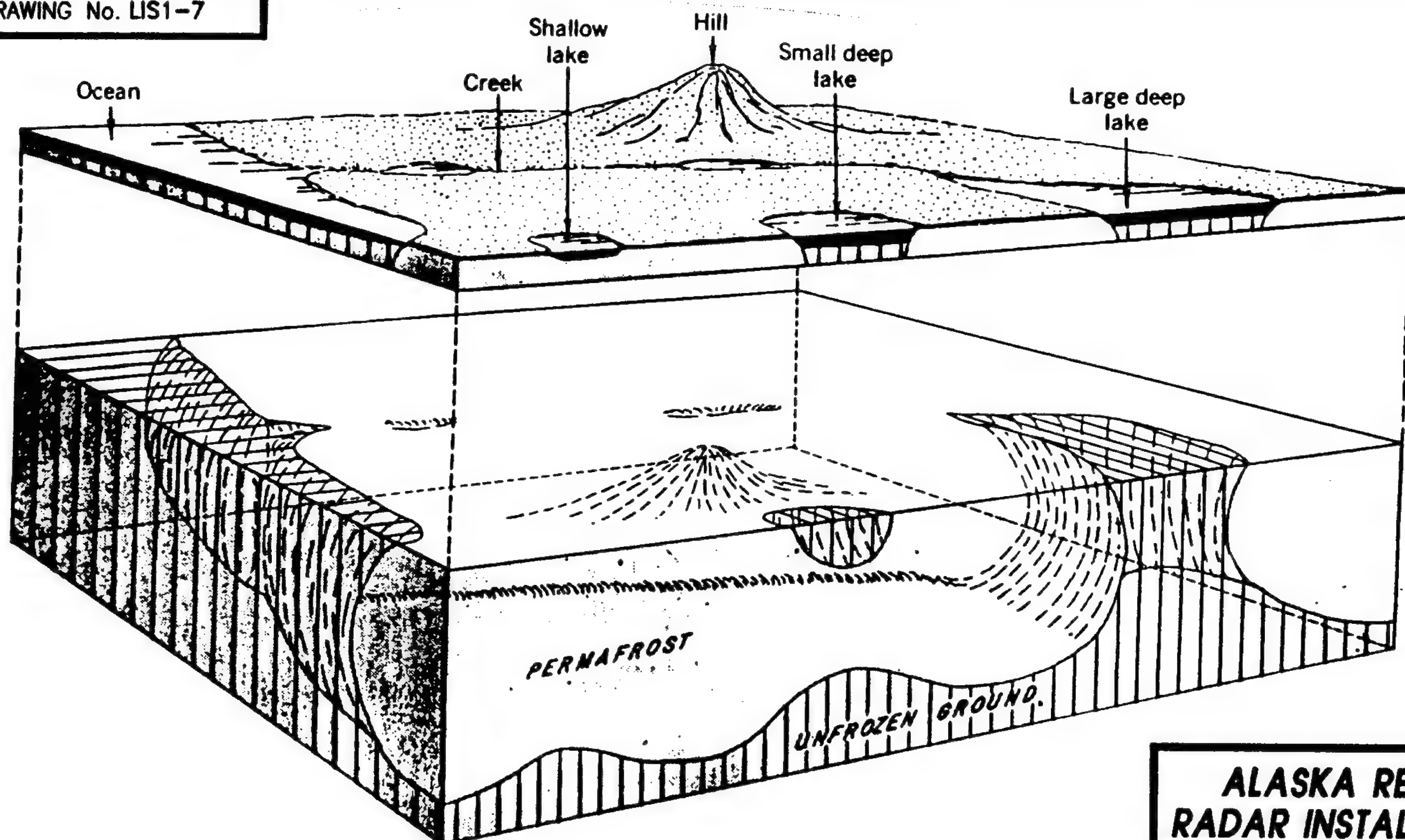
Ground water has been found in aquifers beneath the continuous permafrost, but little is known of these aquifer systems. Shallow ground water sources are also present in river gravel and in thaw bulbs beneath deep lakes. Active zone water is found during the summer months when this layer thaws, but the layer is relatively thin. The thickness of the active zone at Cape Lisburne is estimated to range from 1 to 15 feet.

Surface features may have dramatic impacts on the subsurface distribution of permafrost because they influence heat transfer. Heat flow through surface water is greater than through land. Permafrost may be discontinuous or present at greater depth under and near large bodies of water such as rivers or deep lakes. Smaller bodies of water may affect the configuration of the permafrost surface or the total thickness of the permafrost at any given point. Figure 1-7 is a generalized representation of the relationship of surface features to the underlying permafrost.

1.2.4.2 Surface Water. The drainage of the Cape Lisburne installation is accomplished by suprapermafrost overland flow to diversion channels terminating at the Chukchi Sea. Some installation runoff is directed to Selin Creek, which also discharges to the Chukchi Sea. Selin Creek is significant because the station obtains its water resources from the shallow Water Gallery underlying the stream. The U.S. Army Corps of Engineers has indicated that some minor

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. LIS1-7



SOURCE: Selkregg 1975

ALASKA REMOTE RADAR INSTALLATIONS

USAF 611th CES

FIGURE NO. 1-7

SURFACE FEATURE IMPACTS ON PERMAFROST DISTRIBUTION

THIS PAGE INTENTIONALLY LEFT BLANK

flooding has occurred in a channel next to the runway. The surface water drainage features in the vicinity of the installation are shown on Figure 1-8.

1.2.5 Industrial Activities

Primary industrial activities at the installation include operation and maintenance of the radar system located at the Upper Camp. The Cape Lisburne radar installation was built to support the air defense system in Alaska. The installation became operational in 1953 when communications were provided by high frequency radio. The White Alice Communications system began operation in 1957 and was replaced with an Alascom-owned satellite earth terminal in 1979. Currently there are four people stationed at the Cape Lisburne installation. In the 1970s there were approximately 80 military personnel stationed at the installation to manage the facilities.

Presently, radar equipment, primarily the radome, is located in the Upper Camp along with other inactive facilities, including the White Alice communications structures, tram building, garage, tower, and living quarters. The two camps are connected by a 3.9-mile winding road. The Lower Camp houses support facilities including administrative offices, personnel quarters, vehicle maintenance, welding, fuel storage tanks, incinerator, power and heating plant, sewage lagoon, active landfill, Water Gallery system, and 5,009 feet-long runway. In the Lower Camp there are also many abandoned buildings including transformer buildings, garages, storage buildings, and living quarters.

1.2.6 Biology

This section presents information on the regional fauna and flora of the Cape Lisburne area.

1.2.6.1 Vegetation. The Cape Lisburne installation is bordered by the AMNWR, created in 1980. The terrain near the Cape Lisburne Lower Camp is moderately sloping and within approximately one-half mile rises steeply to the mountains to the south and west to the Upper Camp location. The vegetation habitat type is moist tundra in the lower elevations with alpine tundra in the higher elevations. The predominant flora of this environment type are sedges, *Carex* spp.; tussocks of cottongrass, *Eriophorum* spp.; and dwarf shrubs. Dwarf shrubs are less than three feet high and most common in the Cape Lisburne area are dwarf arctic birch, *Betula nana*; dwarf willow, *Salix* spp.; dwarf alder, *Alnus* spp.; mountain avens, *Dryas* spp.; crowberry, *Empetrum nigrum*; Labrador tea, *Ledum palustri*; bearberry, *Arctostaphylos* spp.; and various herbs, mosses, and lichens (Woodward-Clyde 1988; U.S. Department of the Interior 1988; Spetzman 1959). Also observed in the area are arctic willow, *Salix arctica*; frigid and Lessing's arnica, *Arnica* spp.; cow parsnip, *Heracleum lanatum*; alp lily, *Lloydia serotina*; blackish oxytrope, *Oxytropis nigrescens*; arctic poppy, *Papaver lapponicum*; alpine bluegrass, *Poa arctica*; tall Jacob's ladder, *Polemonium acutiflorum*; buttercup, *Ranunculus* spp.; and large-flowered wintergreen, *Pyrola grandiflora* (Woodward-Clyde 1993; Hart Crowser 1987).

1.2.6.2 Fishes. The Cape Lisburne radar installation has not been cataloged as important for spawning, rearing, or migration of anadromous fishes (ADF&G 1992). Twelve species of freshwater and anadromous fish are known to occur in the streams and lakes of this

THIS PAGE INTENTIONALLY LEFT BLANK

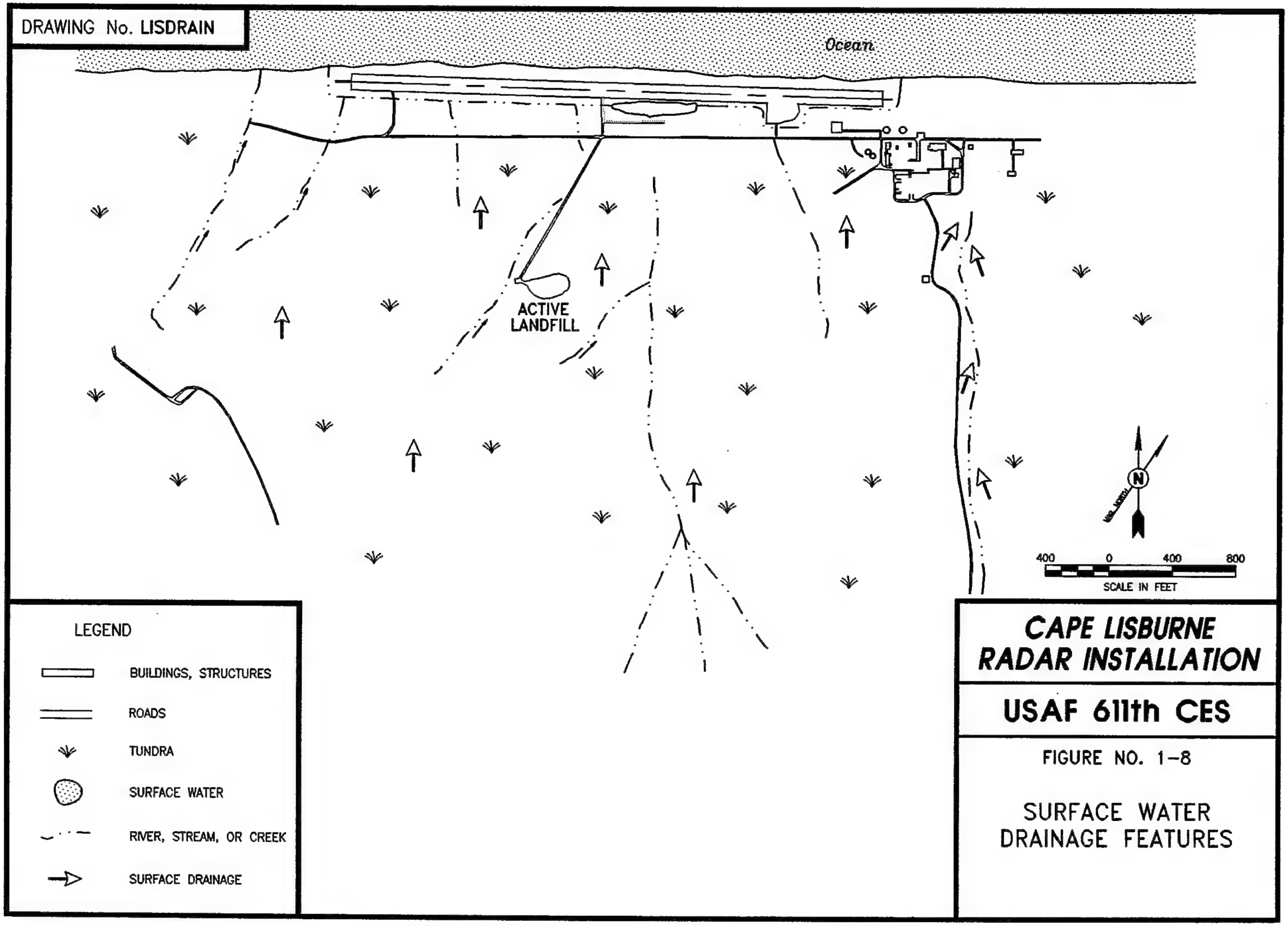


FIGURE NO. 1–8

SURFACE WATER DRAINAGE FEATURES

THIS PAGE INTENTIONALLY LEFT BLANK

region. These species include arctic cisco, *Coregonus autumnalis*; arctic grayling, *Thymallus arcticus*; chum, king, pink, silver, and sockeye salmon, *Oncorhynchus* spp.; slimy sculpin, *Cottus cognatus*; rainbow smelt, *Osmerus mordax*; nine-spined stickleback, *Pungitius pungitius*; arctic char, *Salvelinus alpinus*; Dolly Varden, *S. malma*; and whitefish, *Coregonus* spp. (Woodward-Clyde 1993).

1.2.6.3 Birds. The seabird colonies at Cape Thompson and Cape Lisburne contain the largest concentrations of birds in the Chukchi Sea (which extends from Point Barrow to the northern margin of the Bering Sea), each with over 150,000 breeding birds (U.S. Department of the Interior 1988). In this region of the AMNWR and inland approximately 120 species of birds, including 65 breeding species, have been reported. Several million tufted, *Fratercula cirrhata*, and horned puffins, *F. corniculata*, nest in the AMNWR Chukchi Sea Unit. Other migrant birds common to Cape Lisburne include semipalmated and western sandpipers, *Calidris* spp.; semipalmated plover, *Charadrius semipalmatus*; American golden plover, *Pluvialis dominica*; common and thick-billed murres, *Uria* spp.; black-legged kittiwake, *Rissa tridactyla*; golden eagle, *Aquila chrysaetos*; gyrfalcon, *Falco rusticolus*; and peregrine falcon, *F. peregrinus*. Other birds observed at Cape Lisburne include pelagic cormorant, *Phalacrocorax pelagicus*; snow goose, *Chen caerulescens*; oldsquaw, *Clangula hyemalis*; black scoter, *Melanitta nigra*; long-tailed jaeger, *Stercorarius longicaudus*; glaucous and glaucous-winged gulls, *Larus* spp.; black and pigeon guillemot, *Cepphus* spp.; snowy owl, *Nyctea scandiaca*; common raven, *Corvus corax*; northern wheatear, *Oenanthe oenanthe*; Lapland longspur, *Calcarius lapponicus*; and snow bunting, *Plectrophenax nivalis* (Woodward-Clyde 1993).

1.2.6.4 Mammals. Twenty-one species of mammals were recorded in the vicinity of Cape Lisburne including caribou, *Rangifer tarandus*; gray wolf, *Canis lupus*; brown/grizzly bear, *Ursus arctos*; red fox, *Vulpes vulpes*; arctic ground squirrel, *Spermophilus parryii*; hoary marmot, *Marmota caligata*; arctic fox, *Alopex lagopus*; wolverine, *Gulo luscus*; brown lemming, *Lemmus trimucronatus*; shrews, *Sorex* spp.; voles, *Microtus* spp.; tundra hare, *Lepus othus*; porcupine, *Erethizon dorsatum*; weasels, *Mustela* spp.; mink, *M. vison*; river otter, *Lutra canadensis*; reindeer, *Rangifer arcticus*; and musk ox, *Ovibos moschatus*. A large post-calving aggregation of caribou is located near Cape Lisburne. Brown bears are found in the vicinity between mid-April and early November; the arctic ground squirrel is their principal prey. Some sightings of polar bears, *Ursus maritimus*, have been reported. Wolverine, arctic fox, brown lemming, and bog lemming, *Synaptomys borealis*, are all commonly found near Cape Lisburne.

The Chukchi Sea supports a variety of marine mammals, including walrus, *Odobenus rosmarus*; spotted seal, *Phoca largha*; ringed seal, *P. hispida*; ribbon seal, *P. fasciata*; bearded seal, *Erignathus barbatus*; ten whale species, and polar bear, which occur regularly in the region (Wynne 1992). Walrus have been known to haul out at Cape Lisburne in the late summer when the sea ice has receded to the north (U.S. Department of the Interior 1988).

1.2.6.5 Threatened and Endangered Species. No plant species in the Cape Lisburne area are currently listed as threatened or endangered. Avian species of concern on the Arctic Coastal Plain include spectacled eider, *Somateria fischeri* (threatened), and Steller's eider, *Polysticta stelleri* (candidate for listing), although Alaska Biological Research (1994) conducted surveys for these species and conclude that there is a low probability that spectacled or Steller's

eiders would use the habitats in the vicinity of Cape Lisburne. The bowhead whale, *Balaenoptera mysticetus*, an endangered species, may pass offshore of Cape Lisburne from March to May during its migrations (ADF&G 1986).

1.2.7 Demographics

An average of four personnel are stationed at the Cape Lisburne installation. The nearest settlement is Point Hope (35 miles southwest) with a population of 639 (Alaska Department of Labor 1990), 95 percent of whom are native (Engineering Science 1985).

The vicinity of the station offers more opportunity for recreation than other areas of the Arctic Coast. Although access is limited to commercial and chartered air travel, the station is bordered by the AMNWR, where camping, hiking, hunting, kayaking, cross-country skiing, snowshoeing, and wildlife viewing take place.

1.3 SITE INVENTORY

This section presents information on the IRP sites at the Cape Lisburne radar installation. It includes summaries of previous IRP activities and remedial actions that have been conducted at the installation.

1.3.1 Sites at Cape Lisburne

Five sites and one AOC at the Cape Lisburne radar installation were investigated during the 1993 RI activities. Two sites were determined to be of concern based on previous IRP sampling data. Additionally, there were three sites identified for investigation based on previous IRP activities and the 1993 RI activities. Two sites previously sampled are the Landfill and Waste Accumulation Area (LF01) and the White Alice Site (SS03). Previous IRP sampling at these areas determined that contaminants were present. The installation drinking water supply, the Water Gallery (AOC3), was also previously sampled. This AOC was sampled during the 1993 RI to verify that a previous detection of carbon disulfide at trace levels was due to laboratory or field sampling contamination. Additional sites were identified based on previous IRP activities and the 1993 RI activities as listed: literature search, pre-survey and reconnaissance, interviews with station personnel, communication with personnel from the State of ADEC, and information on disposal practices at DEW Line stations. Additional sites include the Spill/Leak #3 (ST07), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). Prior to this RI/FS, no sampling had been conducted at these three sites.

It should be noted that none of the sites is on, or is proposed for inclusion in, the National Priority List (NPL) of Superfund sites.

1.3.2 Previous IRP Activities

An Air Force contractor conducted Phase I Installation Assessment/Records Search activities at the Cape Lisburne installation and seven other northern installations (Engineering-Science 1985). Phase I activities included field inspection, reviews of installation and AAC records and files, interviews with installation personnel, and evaluations using the HARM system. The Phase I report makes recommendations for Phase II and other IRP activities, including field investigations. It describes six geographical areas of potential concern due to industrial waste disposal, fuel spills, and other issues. The report indicated that further investigation was warranted at all six sites.

An Air Force contractor released the final Technical Support Document for Record of Decision, Cape Lisburne radar installation in 1988 (Woodward-Clyde 1988). The Record of Decision, applicable to six potential hazardous waste sites identified at the Cape Lisburne installation, called for no further action with regard to investigation or cleanup, based on the assessment that there is no significant impact on human health or the environment from suspected or confirmed past contamination.

A draft Site Investigation Report, Cape Lisburne LRR station, Alaska, was released in 1992 (Woodward-Clyde 1992). The site investigation was conducted under the CERCLA (Superfund) program. EPA's estimated HRS score for Cape Lisburne, based on a preliminary assessment, was sufficiently high to warrant further investigation.

1.3.3 Previous Remedial Actions

Prior to this RI/FS investigation, no remedial action had been conducted at the installation. Based on RI observations and analytical data, it was determined that IRAs were necessary at two sites to prevent migration of site contaminants. The Air Force has conducted the two IRAs, which are discussed in the following sections. The IRAs include excavation and containment of a buried drum area at the Landfill and Waste Accumulation (LF01) site, and installation of an interceptor trench and oil/water separator system at the Spill/Leak #3 (ST07) site.

The IRAs conducted at the Landfill Waste Accumulation Area (LF01) and Spill/Leak #3 (ST07) are strictly interim actions. Using information gained from the IRP investigations conducted during the RI/FS, the Air Force will determine remedial actions that will be required at contaminated sites at the Cape Lisburne installation. Preliminary evaluation of RI data has determined that some sites at the installation may require remediation. The proposed actions, if any, for the sites at Cape Lisburne are discussed in Section 4.0.

1.3.3.1 Interim Remedial Action at the Landfill and Waste Accumulation Area (LF01). An IRA was initiated in September 1994 at the Landfill and Waste Accumulation Area site to remove what appeared to be a Sludge Pile/contaminated soils source area that was causing contamination to move downgradient in the natural tundra drainage and towards the Chukchi Sea. Observations made during the 1993 RI conducted at the Cape Lisburne installation indicated that the Sludge Pile area was approximately 200 square feet and extended to a depth of as much as one foot.

During hand excavation in September 1994 at the Sludge Pile, excavated areas filled with water and a thin layer of floating free oily product. As excavation continued, six semi-crushed drums were exposed. After six cubic yards of contaminated soils had been removed and containerized, a geophysical survey was conducted using a metal detector. The survey indicated the presence of between 20 and 30 buried metal objects, presumably drums, in the immediate area. It became apparent that the source of black surface sludge was liquids that had leaked from the buried drums. Henceforth, the Sludge Pile is referred to as the Buried Drum Area.

A continuation of the IRA was scheduled to remove the buried drums prior to the spring thaw, after which surface and active layer water would be likely to fill any excavation. The IRA was initiated on 01 May 1995.

The geophysical survey conducted in September 1994 indicated that buried drums were located beneath an area of approximately 25 feet by 35 feet. On 03 May 1995 the excavation of the buried drums was initiated using the ripper on a D8 bulldozer to loosen the frozen soil and drums. As drums were exposed, any liquids present in the partially crushed and/or ripped drums were transferred into new drums using long-handled scoops. The loosened soils and drums were pushed up into piles and transferred to a containment cell using a large front loader. A metal detector was used during excavation to assist in locating buried drums and determining the direction and depth of further excavation. On 07 May 1995 the excavation of drums was completed.

Approximately 100 drums were excavated over a period of five days. It was estimated that 50 of these drums were full of liquids and the rest were empty, full of ice, or contained ice and product. Approximately 450 gallons of liquid were recovered during the excavation. The majority of liquids appeared to be used motor oils; however, the contents of drums varied from heavy lubricating greases to almost clear liquids that may have contained solvents. Liquids that could not be recovered and poured into drums were scooped up with soil using the heavy equipment and transported to the containment cell. The completed excavation measured approximately 21 feet by 66 feet, with a maximum depth of approximately 6 feet.

Prior to backfilling the excavation with a mixture of gravel and sand from the installation quarry, samples were collected from the bottom and side walls of the excavation, and 80 pounds of calcium peroxide were applied to assist in bioremediation of any residual contaminated soils. During IRA activities in late June 1995, the backfilled area at the site was fertilized and seeded. All excavated soils and debris were placed in a lined containment cell constructed on a gravel-covered area (closed landfill) located approximately 800 feet east of the Buried Drum Area. The cleanup alternatives for the contaminated soils at the site and the soils temporary stored in the on-site containment cell are discussed in Sections 4.0 and 5.0.

1.3.3.2 Interim Remedial Action at Spill/Leak #3 (ST07). An IRA was conducted at the site to collect diesel that is potentially migrating in the subsurface north of POL tanks 1 and 1A. The majority of IRA at the site was conducted from 06 September through 13 September 1994. The interim recovery system constructed consists of a lined interceptor trench installed at the toe of the hill that collects and drains active layer water and liquid petroleum into a centrally located sump. Fluids collected in the sump drain by gravity into an oil-water separator. Diesel drains

from the separator to a poly-tank for temporary storage. The water effluent from the oil/water separator is piped into two 55-gallon drums of activated carbon for treatment and then discharged to the ground surface. The cleanup alternatives for the contaminated soils at the site are discussed in Section 4.0.

The two IRAs are described in detail in the Final Cape Lisburne IRA report (U.S. Air Force 1995).

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 PROJECT ACTIVITIES

This section of the report describes the project objectives and scope, the RI field program and methodology, the analytical programs, background sampling, and analytical results. In addition, data evaluation, risk estimate methodologies, potential migration pathways, and receptors are presented.

2.1 PROJECT OBJECTIVES AND SCOPE

The objectives of the Cape Lisburne radar installation RI/FS are to confirm the presence or absence of chemical contamination in the environment at the installation; define the extent and magnitude of confirmed chemical releases; gather adequate data to determine the magnitude of potential risks to human health and the environment; and gather adequate data to identify and select the appropriate remedial actions for sites where apparent risks exceed acceptable limits or contamination exceeds regulatory guidelines. The project objectives include the following goals:

- Define the horizontal and vertical extent of soil contamination and the range of contaminant concentration;
- Determine the physical and chemical properties of soil contaminants to describe contaminant toxicity and mobility;
- Define the extent of surface and active zone water contamination and the range of contaminant concentrations;
- Describe real and potential surface and subsurface contaminant migration pathways in terms of movement of dissolved and suspended contaminants through the active zone above permafrost, and movement of dissolved and suspended contaminants in surface water;
- Generate adequate valid data to support development of a baseline risk assessment that quantifies, to the extent possible, potential risks to human health and the environment posed by chemicals of concern (COCs) at the Cape Lisburne DEW Line installation studied under this RI; and
- Select the most feasible remedy (cleanup action) to reduce risks at sites where risks exceed acceptable limits.

2.2 RI FIELD ACTIVITIES

This section presents a summary of the field activities conducted during the RI, the organization of the RI field team, and the chronology of field work.

2.2.1 RI Field Program

The RI field program at the Cape Lisburne radar installation was carried out in accordance with the RI/FS Work Plan, the SAP, and the Health and Safety Plan (U.S. Air Force 1993a,b,c). These RI/FS planning documents were developed as specified in the Delivery Order No.22 Statement of Work (Appendix C) and IRP Handbook (U.S. Air Force 1991).

The scope of the field investigation was described in detail in the Field Sampling Plan (U.S. Air Force 1993b). The field activities included the following:

- Collecting and analyzing surface and subsurface soil/sediment samples from sites with potential or confirmed soil/sediment contamination. These soil/sediment samples were described and analyzed for petroleum and other chemical residues. Samples were collected using hand tools.

- Collecting and analyzing samples of surface water from potentially affected streams, surface water features such as lakes or ponds, and any apparent leachate discharge points.

- Collecting and analyzing samples or groundwater from the installation's drinking water supply to confirm the AOC is not affected.

- Collecting and analyzing background samples to characterize natural background conditions.

- Measuring relative surface elevations of sampling points and stream channels to determine surface slopes and stream gradient.

- Collecting samples of potential chemical residues and waste materials at sites where such materials were suspected and had not yet been characterized.

- Conducting real-time air monitoring using portable field instruments.

- Measuring surface distances and approximate elevations to locate sampling points relative to fixed reference points.

The RI activities described above were carried out in three phases as follows:

- Installation Pre-survey. The pre survey was conducted by a small group of contractor employees (four total) accompanied by Air force representatives. The purpose of the pre-survey was to confirm the location of areas of environmental concern at the installation. Pre-survey activities were limited to visual inspection of the sites, surface distance measurements, site photography, and confirmation of the location of structures and sites as shown on installation plan maps. The information gathered from the pre-survey was combined with existing documentation to support development of the RI/FS scoping documents. The

pre-survey was completed at the Cape Lisburne installation on 14 May 1993 by an Air Force contractor.

- Installation Reconnaissance. The installation reconnaissance was conducted on 22 June 1993. The purpose of the reconnaissance was to identify sampling locations of investigation during the RI. The contractor staff made detailed observations of potentially contaminated areas and performed limited intrusive activities (e.g., digging shallow holes with a shovel to determine the apparent depth of contamination at areas of soil staining). Data gathered during the installation reconnaissance provided the basis for determining the sites to be sampled, the approximate number of samples and their locations, analyses for each sample, and equipment and supply needs for the RI.

- Remedial Investigation/Field Activities. The RI field activities were conducted from mid-August through early September of 1993. The RI was conducted in conjunction with RIs at seven other radar installations located throughout northern Alaska. Fifteen contractor employees were stationed in Alaska for the duration of the RI. Sampling activities at the Cape Lisburne radar installation included collection of surface and subsurface soil samples with hand tools (e.g., shovels, scoops, bucket augers) and collection of surface water, bottom sediment, and seep samples from potentially contaminated areas. The RI activities also included operation of temporary northern Alaska (Barrow, Alaska) laboratory facilities operated by a subcontractor.

2.2.2 Field Team Organization and Subcontractors

The organization of the RI field team, the responsibilities of the RI team members, and subcontractors used during RI activities are presented in Figure 2-1 (Note: all Cape Lisburne sampling was conducted by the "B" RI Field Sampling Team). The AFCEE restoration team chiefs that managed and conducted oversight of the RI field activities included Mr. Marty Faile, Mr. Mike McGhee, and Mr. Samer Karmi.

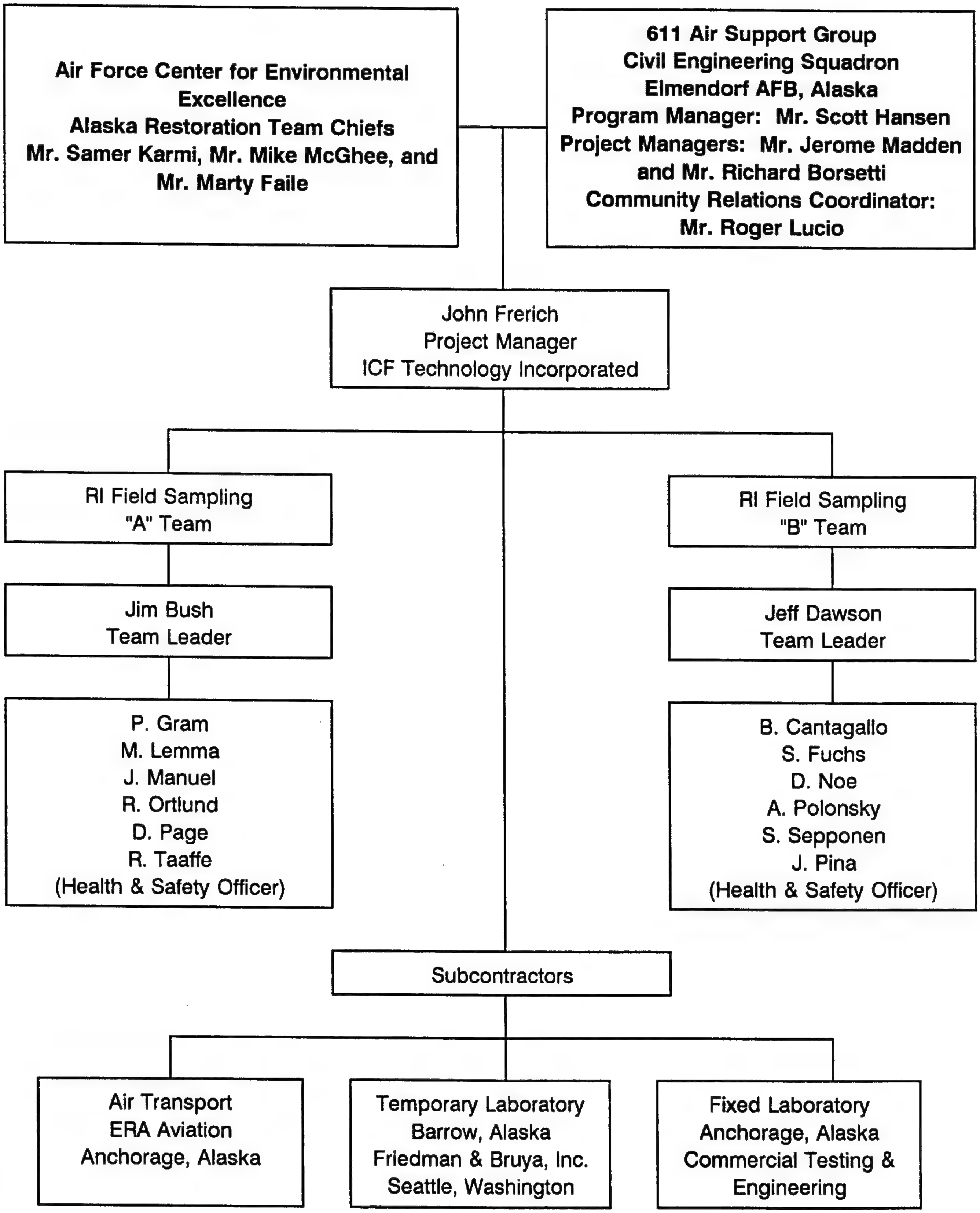
2.2.3 Chronology of Field Work

The RI field work at the Cape Lisburne radar installation conducted during summer of 1993 was accomplished in the following chronological order:

14 May	Conducted pre-survey
22 June	Conducted reconnaissance
27 August	Stockpiled RI sampling supplies at Cape Lisburne radar installation
28 August	Stockpiled RI sampling supplies at Cape Lisburne radar installation

THIS PAGE INTENTIONALLY LEFT BLANK

FIGURE 2-1. FIELD TEAM ORGANIZATION



THIS PAGE INTENTIONALLY LEFT BLANK

29 August	Conducted pre-sampling survey and staked 53 sampling locations at LF01, ST07, SS09, AOC3, and background.
30 August	Staked 11 sampling locations at SS03 and SS08. Collected 5 soil and 2 water background samples, 6 soil samples at SS03, 6 soil samples at SS08, 11 soil samples SS09, 5 water samples at AOC3, and 2 QA/QC samples. Inventoried contents of the deactivated White Alice garage.
31 August	Collected 17 soil and 7 water samples LF01 and 3 QA/QC samples.
01 September	Staked 11 sampling locations at ST07. Collected 17 soil and 3 water samples at ST07 and 2 QA/QC samples.
09 September	Staked 23 sampling locations at LF01, SS03, ST07, and SS08. Collected six soil and thee water samples at LF01, six soil samples at SS03, nine soil and two water samples at ST07, two soil samples at SS08, one water sample at AOC3, one investigation derived waste (IDW) sample, and two QA/QC samples.

In addition, RI field work was conducted during the 1994 and 1995 IRA activities to further characterize the sites at the Cape Lisburne radar installation in the following chronological order:

07 September 1994	Collected five soil samples at LF01, two soil samples at SS03, one soil sample at SS08, three soil samples at SS09, and two QA/QC samples.
08 September 1994	Collected 10 soil samples at ST07.
09 September 1994	Collected one soil sample at ST07 and one QA/QC sample.
10 September 1994	Collected one soil sample SS03.
11 September 1994	Collected one soil sample at LF01 and two QA/QC samples.
07 May 1995	Collected three soil samples at LF01 and one QA/QC sample.
23 June 1995	Collected seven soil samples for background, nine soil samples at LF01, and two QA/QC samples.
24 June 1995	Collected four soil samples at LF01.
25 June 1995	Collected one soil sample at LF01.
26 June 1995	Collected three soil samples at LF01 and one QA/QC sample.

27 June 1995	Collected two soil samples for background, three soil samples at LF01, and one QA/QC sample.

2.3 RI SAMPLING AND ANALYSES

A summary of the RI sampling and analysis activities conducted during this investigation is presented in this section. Included are descriptions of the number of samples collected by media, QA/QC control samples collected, background sampling and analyses, analytical programs, chronology of laboratory analyses, laboratory QA/QC programs, and data validation and reporting.

2.3.1 Sampling Procedures

Contractor personnel collected samples from various media at the Cape Lisburne radar installation using numerous sample collection methods and procedures. The collection methods were determined at the time of collection, based on sample location and prevailing environmental conditions. Media sampled during the RI included surface and subsurface soils, surface water, ground water, and sediment. These media were extracted generally from man-emplaced fill, gravel pads, and scraped areas; and natural tundra soils/sediments and surface water bodies. All sampling tools and other devices used during sampling were decontaminated before use. Standard procedures, developed by the contractor for sampling methodologies used during the RI, are presented in Appendix D of the RI/FS SAP (U.S. Air Force 1993b). Sample collected logs for all samples collected during RI activities at the Cape Lisburne installation are presented in Appendix D of this report. The logs provide detailed sample information such as media, location, depth, and analyses requested. Completed chain-of-custody forms for all samples collected during the RI at the Cape Lisburne installation are presented in Appendix E.

2.3.2 Summary of RI Summary

Contractor personnel collected 189 samples from various media at the Cape Lisburne radar installation. Fourteen samples were collected to determine organic and inorganic background concentrations in soil/sediment and surface water. Thirty-four samples were collected for QA/QC. QA/QC samples included duplicates, replicates, equipment blanks, trip blanks, and ambient condition blanks. One-hundred and eighty-seven samples were collected to determine the nature and extent of contamination at the five sites and one AOC at Cape Lisburne. Two samples were collected of the IDWs. Table 2-1 presents a summary of RI sampling conducted at Cape Lisburne.

2.3.2.1 Field QA/QC Samples. The field QA/QC program consisted of QA/QC samples, QC checks, and limits for field procedures.

QA/QC Samples. QA/QC samples collected during this investigations included duplicate water samples, replicate soil/sediment samples, trip blanks, ambient condition blanks, and equipment rinsate blanks.

TABLE 2-1. SUMMARY OF CAPE LISBURNE REMEDIAL INVESTIGATION FIELD SAMPLING ACTIVITIES

ACTIVITY	TOTAL
Water Samples Collected for Lab Analyses (including QA/QC)	42 samples
Soil/sediment Samples Collected for Lab Analyses (including QA/QC)	145 samples
Drums of Investigation Derived Waste Generated (one drum water and one drum soil)	2 samples
TOTAL WATER AND SOIL SAMPLES FOR LAB ANALYSES	189 samples

QA/QC samples collected during RI sampling activities at the Cape Lisburne radar installation were as follows: 3 duplicate water samples, 8 replicate soil/sediment samples, 10 trip blanks, 2 ambient condition blanks, and 9 equipment rinsate blanks. Table 2-2 summarizes all samples, including QA/QC samples, collected and analyzed during RI activities at the installation.

In addition, extract volumes of selected samples were collected and submitted for internal laboratory QA/QC (matrix spike and matrix spike duplicates). Extra sample volumes were submitted at a minimum of 1 per 10 samples. Extra volumes submitted included triple volume for organic water analyses and double volume for inorganic water analyses.

2.3.2.2 Background Sampling and Analyses. Fourteen background samples were collected from areas in the Lower Camp during field activities at the Cape Lisburne radar installation, to establish background concentrations for naturally occurring organic compounds. In order to obtain a representative range of inorganic (metal) concentrations in soil/sediments and surface waters, seven samples (five soil/sediment and two water) were collected.

Fourteen background samples were collected from tundra, drainage pathways, ponds, and the ocean floor during the RI at Cape Lisburne. These consisted of four soil, six sediment, two ocean floor sediment, and two surface water samples.

Four background soil samples were analyzed for DRPH, GRPH, RRPH, BTEX, halogenated volatile organic compounds (HVOCs), VOCs, pesticides, PCBs, and total metals. In addition, two samples were analyzed for SVOCs. One sample was analyzed for total organic carbon (TOC).

Six background sediment samples were collected and analyzed for PCBs. In additions, one sample was analyzed for DRPH, GRPH, RRPH, BTEX, HVOCs, VOCs, SVOCs, pesticides, PCBs, total metals, and TOC.

The two background ocean floor sediment samples collected were analyzed for PCBs.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-2. SUMMARY OF SAMPLING AND ANALYSES CONDUCTED F

ANALYSES	HVOC*	BTEX*	VOC 8260	SVOC	Metals[a]	TPH-Diesel[b] Range 3510/3550	TI
ANALYTICAL METHOD	SW8010M	SW8020	SW8260	SW8270	SW3050 (Soil) 3005 (Water)/6010	Diesel 8100M	Ga
						CAPE LISBURNE	
Background (BKGD)	5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water	3 Soil 2 Water	5 Soil 2 Water (Total) 2 Water (Dissolved)	5 Soil 2 Water	
Landfill Waste Accumulation Area (LF01)	13 Soil	13 Soil 6 Water	12 Soil 5 Water	11 Soil 6 Water	4 Soil 4 Water (Total) 4 Water (Dissolved)	19 Soil 8 Water	
White Alice Site (SS03)	NA	NA	NA	NA	NA	11 Soil	
Spill/Leak #3 (ST07)	NA	27 Soil 1 Water	9 Soil 2 Water	1 Soil 1 Water	NA	36 Soil 2 Water	
Upper Camp Transformer Building (SS08)	NA	NA	NA	NA	NA	7 Soil	
Lower Camp Transformer Buildings (SS09)	NA	NA	NA	NA	NA	10 Soil	
Water Gallery (AOC3)	NA	NA	5 Water	5 Water	5 Water (Total) 4 Water (Dissolved)	1 Water	
Total Field Analyses	18 Soil 2 Water	45 Soil 9 Water	40 Soil 14 Water	15 Soil 14 Water	9 Soil 11 Water (Total) 10 Water (Dissolved)	88 Soil 13 Water	
QA/QC SAMPLES							
Trip Blanks	2 Water	4 Water	9 Water	NA	NA	NA	
Equipment Blanks	2 Water	4 Water	5 Water	2 Water	2 Water (Total) 1 Water (Dissolved)	5 Water	
Ambient Condition Blanks	NA	NA	2 Water	NA	NA	NA	
Field Replicates	2 Soil	3 Soil	5 Soil	3 Soil	2 Soil	7 Soil	
Field Duplicates	NA	2 Water	3 Water	2 Water	1 Water (Total) 1 Water (Dissolved)	3 Water	
Total Site Analyses	20 Soil 6 Water	48 Soil 19 Water	45 Soil 33 Water	18 Soil 18 Water	11 Soil 14 Water (Total) 12 Water (Dissolved)	95 Soil 21 Water	

NA Not analyzed.
* These analyses were completed on a quick turnaround basis.
[a] The number of soil sample includes sediment samples collected from surface water features.
[b] Some of these analysis were completed on a 24-hour turnaround at a temporary fixed laboratory at Barrow, Alaska.

ONDUCTED FOR CAPE LISBURNE REMEDIAL INVESTIGATIONS[a]

TPH-Diesel[b] Range 3510/3550	TPH - Gasoline Range	TPH Residual Range*	PCB*	Pesticides*	TDS	TSS	TOC	TOTAL SAMPLES
Diesel 8100M	Gas 5030/8015M	Diesel 8100M	SW8080/8080M	SW8080/8080M	E160.1	E160.2	SW9060	
CAPE LISBURNE								
5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water	2 Water	2 Water	2 Soil 2 Water	12 Soil 2 Water
19 Soil 8 Water	22 Soil 6 Water	19 Soil 8 Water	41 Soil 6 Water	1 Soil 1 Water	4 Water	4 Water	4 Water	47 Soil 8 Water
11 Soil	NA	11 Soil	16 Soil	1 Soil	NA	NA	NA	16 Soil
36 Soil 2 Water	16 Soil 1 Water	26 Soil 2 Water	NA	1 Soil 1 Water	2 Water	2 Water	1 Water	36 Soil 2 Water
7 Soil	NA	7 Soil	8 Soil	NA	NA	NA	1 Soil	8 Soil
10 Soil	NA	10 Soil	13 Soil	1 Soil	NA	NA	NA	13 Soil
1 Water	NA	1 Water	2 Water	5 Water	4 Water	4 Water	4 Water	5 Water
88 Soil 13 Water	43 Soil 9 Water	78 Soil 13 Water	90 Soil 10 Water	9 Soil 9 Water	12 Water	12 Water	2 Soil 11 Water	132 Soil 17 Water
NA	3 Water	NA	NA	NA	NA	NA	NA	10 Water
5 Water	4 Water	4 Water	4 Water	3 Water	NA	NA	NA	9 Water
NA	NA	NA	3 Water	NA	NA	NA	NA	2 Water
7 Soil	4 Soil	7 Soil	5 Soil	1 Soil	NA	NA	1 Soil	8 Soil
3 Water	2 Water	3 Water	1 Water	1 Water	2 Water	2 Water	2 Water	3 Water
95 Soil 21 Water	47 Soil 18 Water	85 Soil 20 Water	95 Soil 18 Water	10 Soil 13 Water	14 Water	14 Water	3 Soil 13 Water	140 Soil 41 Water

Barrow, Alaska.

Two background surface water samples were collected from streams and ponds during the RI. Both of the samples were analyzed for DRPH, GRPH, BTEX, HVOCs, VOCs, SVOCs, PCBs, pesticides, TOC, total suspended solids (TSS), total dissolved solids (TDS), and total and dissolved metals.

Data Summary. Background sample locations at Cape Lisburne are illustrated in Figure 2-2. The data summary table (Table 2-3) presents analytical results for all background samples collected at Cape Lisburne. Detection and quantitation limits, action levels, and associated field and laboratory blank results are included on the data summary table.

Below is a discussion of organic compounds and inorganic analytes detected in background samples at Cape Lisburne. A discussion of TDS, TSS, and TOC is included. Analytical results are presented in Table 2-3 and Figure 2-2.

Organics. DRPH were detected in background soil and sediment samples. DRPH were detected in all seven of the background soil and sediment samples at concentrations ranging from 9.55 to 1,150 mg/kg. DRPH are assumed to be the result of naturally occurring biogenic hydrocarbons; DRPH in background samples were identified by the laboratory as not being consistent with middle distillate fuels. Although some naturally occurring compounds were detected in the DRPH analyses of some of the soil/sediment background samples, the organic concentration in background samples is assumed to be non-detect. This conservative approach was used because it is not possible to determine the degree to which the DRPH detected in site samples were naturally occurring compounds. PCB was detected in one background soil sample and this detection is assumed to be a false positive. PCB concentrations in background areas are assumed to be non-detect. The range of background concentrations detected for all analytes is presented in data summary tables for each of the sites discussed in Sections 3.0 and 4.0.

One organic compound was detected in background water samples collected at Cape Lisburne. This compound, 1,2-dichloroethane, was detected in the two background water samples at 3.0 and 3.2 μg/L. It was also detected in associated blank samples and is assumed to be the result of field decontamination procedures. The hexane and methanol used in the decontamination procedures may have contained impurities including 1,2-dichloroethane. 1,2-Dichloroethane was detected at similar concentrations in numerous field blank samples.

Inorganics. Fourteen metals were detected in background soil sediment samples at Cape Lisburne. The results of inorganic analytes are presented in Table 2-3. TOC was reported at 199,000 and 32,000 mg/kg in samples BKGD-S02 and BKGD-SD01, respectively.

Five metals were detected in background surface water samples collected at Cape Lisburne. The results of inorganic analyses are presented in Table 2-3. TOC was reported at 12,700 μg/L in surface water sample BKGD-SW02. TSS and TDS were reported at 8,000 and 328,000 μg/L, respectively, in surface water sample BKGD-SW01.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne
Site: Background (BKGD)
Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples					Field Blanks			Lab Blanks	
					S01	S02	S03	S04	SD01	AB01	EB01	TB01		
Laboratory Sample ID Numbers					1382/1554 4477-1 4476-2	1555/1556 4481-4	1574 4481-5	1576 4481-6	1381/1557 4477-2 4476-3	4512-3	1558 1561 4476-5	1552 4476-1	#1&2-9493 #1&2-9793 #6-9393 4476/4512	#3&4-9493 #6-9593 #6-9293 4481\4476\4477
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-15	60-150	500[a]	<60[b]-<150[b]	<130[b]	<60[b]	<120[b]	<150[b]	<60[b]	NA	<1,000J[b]	NA	<2,000	<50
GRPH	0.2-0.6	2-6	100	<2J[b]-<6J[b]	<4J[b]	<2J[b]	<4J[b]	<6J[b]	<2J[b]	NA	<50J[b]	<50J[b]	<50	<1-<20
RRPH (Approx.)	12-30	120-300	2,000[a]	<120-<300	<160	<120	<240	<300	<120	NA	<2,000	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	<0.2	<0.15	<0.2	<0.3	<0.1					
Benzene	0.002-0.006	0.02-0.06	0.5	<0.02-<0.06	<0.04	<0.03	<0.04J	<0.06	<0.02	<1[c]	<1	5JN	<1	<0.02-<0.2
Toluene	0.002-0.006	0.02-0.06		<0.02-<0.06	<0.04	<0.03	<0.04	<0.06	<0.02	<1[c]	<1	1N	<1	<0.02-<0.2
Ethylbenzene	0.002-0.006	0.02-0.06		<0.02-<0.06	<0.04	<0.03	<0.04	<0.06	<0.02	<1[c]	<1	1N	<1	<0.02-<0.2
Xylenes (Total)	0.004-0.012	0.04-0.12		<0.04-<0.12	<0.08	<0.06	<0.08	<0.12	<0.04	<2[c]	<2	5JN	<2	<0.04-<0.4
HVOC 8010	0.002-0.006	0.02-0.06		<0.02J-<0.06J	<0.04J	<0.03J	<0.04J	<0.06J	<0.02J	NA	<1J-<10J	<1J	<1-<10J	<0.02
VOC 8260														
Methylene Chloride	0.020	0.025-0.160	90	<0.025-<0.160	<0.040	<0.030	<0.160	<0.1	<0.025	13J	<1	1.7	<1	<0.020
SVOC 8270														
di-n-Butylphthalate	0.200	0.250-4.23	8,000	1.61U-20.4JB	1.61U	2.19U	NA	NA	20.4JB	NA	<10	NA	<10	0.878
Pesticides														
Dieldrin	0.001-1	0.01-10	0.04	<0.01J-0.07R	0.07R	<0.01J	<0.01J	<0.01J	<0.01	NA	<0.2J-<10J	NA	NA	<0.01-<0.5

- ☐ CT&E Data.
- ▩ F&B Data.
- NA Not analyzed.
- B The analyte was detected in the associated blank.
- N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
- R Result has been rejected.
- U Compound is not present above the concentration listed.
- a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
- b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
- c BTEX determined by 8260 method analysis.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne Matrix: Soil/Sediment
Site: Background (BKGD) Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples					Field Blanks			Lab Blanks	
					S01	S02	S03	S04	SD01	AB01	EB01	TB01		
Laboratory Sample ID Numbers					1382/1554 4477-1 4476-2	1555/1556 4481-4	1574 4481-5	1576 4481-6	1381/1557 4477-2 4476-3	4512-3	1558 1561 4476-5	1552 4476-1	#1&2-9493 #1&2-9793 #6-9393 4476/4512	#3&4-9493 #6-9593 #6-9293 4481\4476\4477
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
PCBs														
Aroclor 1260	0.01	0.1	10	<0.02-20JN	20JN	<0.1	<0.2	<0.3	<0.1	NA	<2J	NA	NA	<0.1
TOC				25,700-77,900	77,900	NA	NA	NA	25,700	NA	NA	NA	NA	NA

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Background (BKGD)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples						Field Blank			Lab Blanks
					S01	S02	S03	S04	SD01			EB01		
Laboratory Sample ID Numbers					4477-1	4481-4	4481-5	4481-6	4477-2			4476-5		4477 4476 4481
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L		µg/L
Aluminum	0.35	2		4,700-17,000	4,700	17,000	5,000	10,500	6,300			<100		<100
Antimony	N/A	61-110		<61-<110	<95J	<61	<110	<69	<63J			<100		<100
Arsenic	0.11	6.3-69		<6.3-<69	<9.5	<61	<11	<69	<6.3			<100		<100
Barium	0.024	1		590-2,000	590	1,100	940	2,000	800			<50		<50
Beryllium	N/A	3.2-35		<3.2-<35	<4.8	<31	<5.4	<35	<3.2			<50		<50
Cadmium	0.33	31-54		<31-<54	<48	<31	<54	<35	<32			<50		<50
Calcium	0.69	4		2,700-240,000	240,000	2,700	26,000	8,900	8,500			210		<200
Chromium	0.066	1		9.3-33	9.3	33	13	24	11			<50		<50
Cobalt	N/A	1-11		<6.3-17	11	13	<11	17	<6.3			<100		<100
Copper	0.045	1		12-71	16	36	71	50	12			<50		<50
Iron	0.50	2		5,400-39,000	25,000	28,000	11,000	39,000	5,400			110		<100
Lead	0.13	2-69		<9.5-7.0	<9.5	<61	<11	<69	7.0			<100		<100
Magnesium	0.96	4		1,000-34,000	34,000	5,100	2,400	2,000	1,000			<200		<200
Manganese	0.025	1		15J-1,000J	1,000J	270	780	910	15J			<50		<50
Molybdenum	N/A	3.1-35		<3.1-<35	<4.8	<3.1	<5.4	<35	<3.2			<50		<50
Nickel	0.11	1		13-80	33	60	80	34	13			<50		<50
Potassium	23	100-540		<540-2,600	2,100	2,600	<540	570	640			<5,000		<5,000

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Background (BKGD)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples						Field Blank			Lab Blanks
					S01	S02	S03	S04	SD01			EB01		
Laboratory Sample ID Numbers					4477-1	4481-4	4481-5	4481-6	4477-2			4476-5		4477 4476 4481
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L		µg/L
Selenium	1.2	61-110		<61-<110	<95	<61	<110	<69	<63			<100		<100
Silver	0.53	31-54		<31-<54	<48J	<31	<54	<35	<32J			<50		<50
Sodium	0.55	5		58-120	89	100	120	110	58			360		<250
Thallium	0.011	0.31-0.52		<0.31-<0.52	<0.51	<0.31	<0.52	<0.35	<0.31			<5		<5
Vanadium	0.036	1		19-58	19	46	32	58	21			<50		<50
Zinc	0.16	1		40J-250	130J	130	250	67	40J			<50		<50

□ CT&E Data.
J Result is an estimate.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Background (BKGD)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples					Field Blank	Lab Blanks	
					5SD01	5SD02	5SD03-2	5SD04	5SD05	3EB02		
Laboratory Sample ID Numbers					2592-1	2592-2	2592-3	2592-4	2592-5	4742-2	4742	2592
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
PCBs	0.02	0.02-0.04	10	<0.02-20JN	<0.02	<0.03	<0.04	<0.02	<0.02	<1	<1	<0.02

□ CT&E Data.
▩ F&B Data.
NA Not available.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne   Matrix: Surface Water
Site: Background (BKGD)   Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples				Field Blanks			Lab Blanks
					SW01	SW02			AB01	EB01	TB01	
Laboratory Sample ID Numbers					1562/1564 4477-5 4476-6	1566/1568 4477-6 4476-7			4512-3	1558/1561 4476-5	1552	#1&2-9493 #1&2-9793 #6-9393 4512 4476 4477
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			µg/L	µg/L	µg/L	µg/L
DRPH	<100	<1,000		<1,000[b]	<1,000J[b]	<1,000[b]			NA	<1,000J[b]	NA	<2,000
GRPH	<5	<50		<50J[b]	<50J[b]	<50J[b]			NA	<50J[b]	<50J[b]	<50
RRPH (Approx.)	<200	<2,000		<2,000	<2,000	<2,000			NA	<2,000	NA	<4,000
BTEX (8020/8020 Mod.)												
Benzene	0.1-1	1	5	<1[c]	<1[c]	<1[c]			<1[c]	<1[c]	<1[c]	<1
Toluene	0.1-1	1	1,000	<1[c]	<1[c]	<1[c]			<1[c]	<1[c]	<1[c]	<1
Ethylbenzene	0.1-1	1	700	<1[c]	<1[c]	<1[c]			<1[c]	<1[c]	<1[c]	<1
Xylenes (Total)	0.2-2	2	10,000	<2[c]	<2[c]	<2[c]			<2[c]	<2[c]	<2[c]	<2
HVOC 8010	0.1-1	1		<1J	<1J	<1J			NA	<1J-<10J	<1J	<1-<10J
VOC 8260												
Methylene Chloride	1	1	5	<1	<1	<1			13J	<1	1.7	<1
SVOC 8270	10	10		<10	<10	<10			NA	<10	NA	<10

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Background (BKGD)
Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples				Field Blanks			Lab Blanks
					SW01	SW02			AB01	EB01	TB01	
Laboratory Sample ID Numbers					1562/1564 4477-5 4476-6	1566/1568 4477-6 4476-7			4512-3	1558/1561 4476-5	1552	#1&2-9493 #1&2-9793 #6-9393 4512 4476 4477
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			µg/L	µg/L	µg/L	µg/L
Pesticides	0.02-1	0.2-10		<0.2J-<10J	<0.2J-<10J	<0.2-<10			NA	<0.2J-<10J	NA	NA
PCBs	0.2	2	0.5	<2J	<2J	<2J			NA	<2J	NA	NA
TOC	5,000	5,000		<5,000-15,600	<5,000	15,600			NA	NA	NA	<5,000
TSS	100	200		2,500-3,000	2,500	3,000			NA	NA	NA	<200
TDS	10,000	10,000		203,000-245,000	245,000	203,000			NA	NA	NA	<10,000

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Background (BKGD)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples						Field Blank		Lab Blanks
					SW01	SW02						EB01	
Laboratory Sample ID Numbers					4477-5	4477-6						4476-5	4477 4476
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Aluminum	17.4	100		<100 (<100)	<100 (<100J)	<100 (<100)						<100	<100
Antimony	N/A	100	6	<100 (<100)	<100 (<100)	<100 (<100)						<100	<100
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)	<100 (<100)						<100	<100
Barium	1.2	50	2,000	79-92 (73-89)	92 (89)	79 (73)						<50	<50
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Calcium	34.5	200		28,000-41,000 (28,000-41,000)	41,000 (41,000)	28,000 (28,000)						210	<200
Chromium	3.3	50	100	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Cobalt	N/A	100		<100 (<100)	<100 (<100)	<100 (<100)						<100	<100
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Iron	25.0	100		<100-190 (<100)	<100 (<100)	190 (<100)						110	<100
Lead	6.6	100	15	<100 (<100)	<100 (<100)	<100 (<100)						<100	<100

☐ CT&E Data.
N/A Not analyzed.
J Result is an estimate.

TABLE 2-3. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

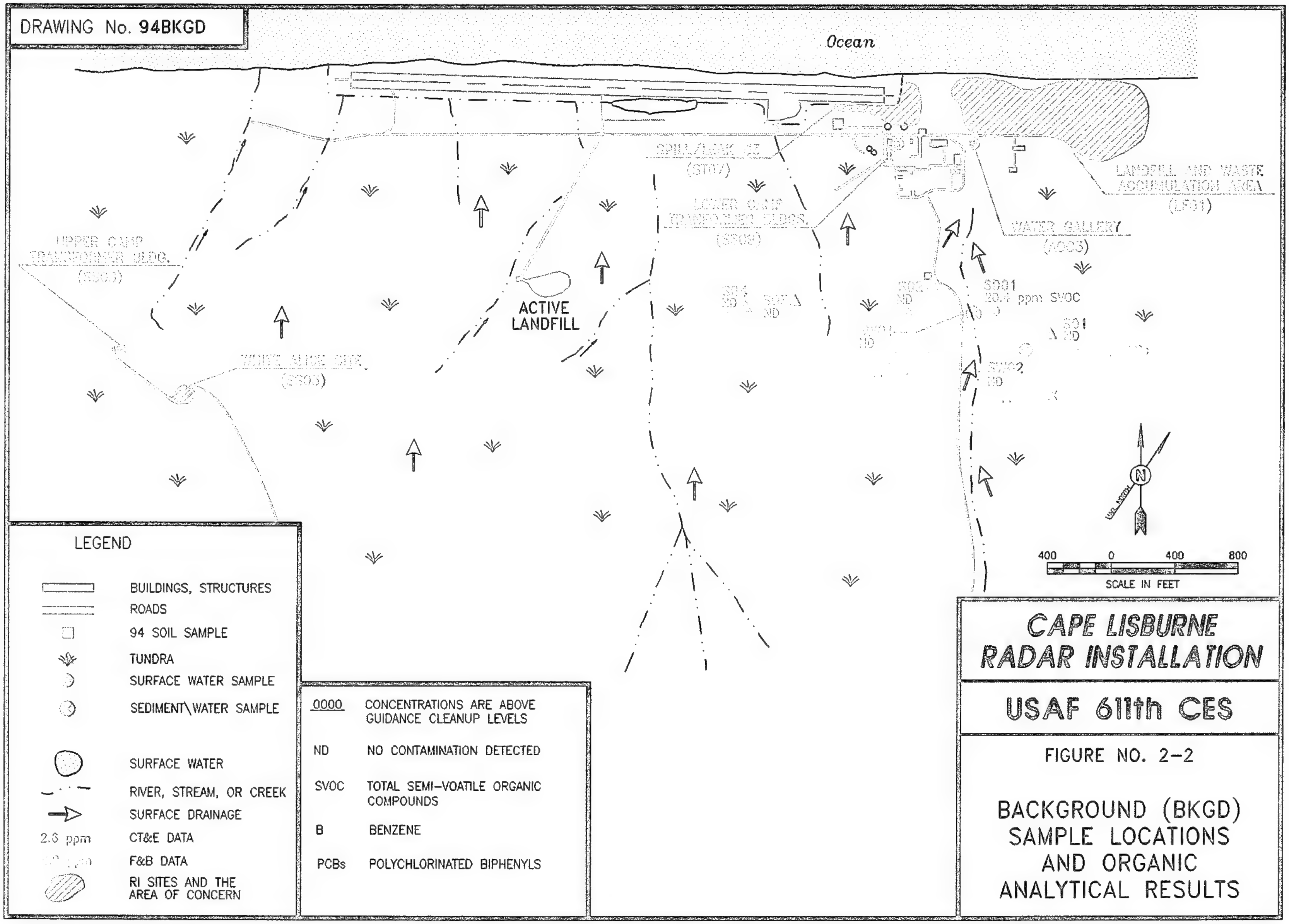
Installation: Cape Lisburne
Site: Background (BKGD)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range	Environmental Samples						Field Blank		Lab Blanks
					SW01	SW02						EB01	
Laboratory Sample ID Numbers					4477-5	4477-6						4476-5	4477 4476
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Magnesium	47.8	200		4,500-9,000 (4,500-8,800)	9,000 (8,800)	4,500 (4,500)						<200	<200
Manganese	1.2	50		<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Molybdenum	N/A	50		<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Nickel	5.5	50	100	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Potassium	1,154	5,000		<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)						<5,000	<5,000
Selenium	62.4	100	50	<100 (<100)	<100 (<100)	<100 (<100)						<100	<100
Silver	2.6	50	50	<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Sodium	27.7	250		4,000-5,600 (3,900-6,000)	4,000 (3,900)	5,600 (6,000)						360	<250
Thallium	0.571	5	2	<5 (<5)	<5 (<5)	<5 (<5)						<5	<5
Vanadium	1.8	50		<50 (<50)	<50 (<50)	<50 (<50)						<50	<50
Zinc	8.2	50		<50-260 (<50)	260 (<50)	<50 (<50)						<50	<50

☐ CT&E Data.
N/A Not analyzed.


DRAWING No. 94BKGD
Ocean
UPPER CAMP TRANSFORMER BLDG. (SS03)
WHITE ALICE SITE (SS03)
ACTIVE LANDFILL
SPILL/LEAK #2 (ST07)
LOWER CAMP TRANSFORMER BLDGS. (SS08)
WATER GALLERY (AOC3)
LANDFILL AND WASTE ACCUMULATION AREA (LF01)
SD01
20.4 ppm SVOC
SW02
ND
400
0
400
800
SCALE IN FEET
LEGEND
BUILDINGS, STRUCTURES
ROADS
94 SOIL SAMPLE
TUNDRA
SURFACE WATER SAMPLE
SEDIMENT\WATER SAMPLE
SURFACE WATER
RIVER, STREAM, OR CREEK
SURFACE DRAINAGE
2.3 ppm CT&E DATA
F&B DATA
RI SITES AND THE AREA OF CONCERN
0000 CONCENTRATIONS ARE ABOVE GUIDANCE CLEANUP LEVELS
ND NO CONTAMINATION DETECTED
SVOC TOTAL SEMI-VOATILE ORGANIC COMPOUNDS
B BENZENE
PCBs POLYCHLORINATED BIPHENYLS
CAPE LISBURNE RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-2
BACKGROUND (BKGD) SAMPLE LOCATIONS AND ORGANIC ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

2.3.3 Laboratory Analyses

This section describes the RI analytical program. Summaries of the soil/sediment and water analyses conducted during the RI are presented in Tables 2-4 and 2-5. Table 2-4 presents a description of the soil analytical methods and number of soil samples collected, and Table 2-5 presents a description of the water analytical methods and the number of water samples collected.

2.3.3.1 Analytical Program. Analyses of samples were conducted by a fixed laboratory in Anchorage, Alaska, and a temporary laboratory set up at Barrow, Alaska. The analytical testing conducted by each laboratory is discussed below.

The fixed laboratory in Anchorage, Alaska, was operated by Commercial Testing and Engineering (CT&E). CT&E analyzed samples for the following constituents:

Analyses	Analytical Method
Volatile Organic Compounds (VOC)	SW5030/8260
Metals	SW3050 (Soil) 3005 (Water)/6010
Semi-Volatile Organic Compounds (SVOCs)	SW3550 (Soil) 3510 (Water)/8270
Total Dissolved Solids (TDS)	E160.1
Total Suspended Solids (TSS)	E160.5
Total Organic Carbon (TOC)	SW9060
Moisture Content	ASTM D 2216
Toxicity Characteristics Leaching (TCLP)	SW1311

In addition, for the first few weeks of the field activities, CT&E provided the following analyses on a quick turnaround basis:

Analyses	Analytical Method
Halogenated Volatile Organic Compounds (HVOCs)	SW5030/8010
Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)	SW5030/8020
Gasoline Range Petroleum Hydrocarbons (GRPH)	8015 Modified
Diesel Range Petroleum Hydrocarbons (DRPH)	8100 Modified
Polychlorinated Biphenyls/Pesticides	SW5030/8080

Analyses	Analytical Method
Halogenated Volatile Organic Compounds (Four compounds only)	SW5030/8010 Modified
Benzene, Toluene, Ethylbenzene, and Xylenes	SW5030/8020 Modified
Polychlorinated Biphenyls/Pesticides	SW3550/8080 Modified
Diesel Range Organics (DRO)	8100 Modified
Gasoline Range Organics (GRO)	8010/8020/8015 Modified
Residual Range Organics	8100 Modified

TABLE 2-4. ANALYTICAL METHODS AND TOTAL NUMBER OF SOIL ANALYSES

SOIL ANALYSES	ANALYTICAL METHOD	REPORTING UNITS	NUMBER OF ANALYSES	REPLICATES	TOTAL ANALYSES
Volatile Organics	SW5030/8260	mg/kg	40	5	45
Semi-Volatile Organics	SW3550/8270	mg/kg	15	3	18
Total Metals Analysis --ICP Screen	SW3050/6010	mg/kg	9	2	11
TOC, Soil	SW9060	mg/kg	2	1	3
TPH - Diesel Range	SW3510/3550/8100M	mg/kg	89	7	96
TPH - Gasoline Range	SW5030/8015M	mg/kg	43	4	47
TPH - Residual Oil	SW3510/3550/8100M	mg/kg	78	7	85
BTEX	SW5030/8020/8020M	mg/kg	45	3	48
Halogenated Volatile Organic Compounds	SW5030/8010M	mg/kg	18	2	20
PCB	SW5030/8080/8080M	mg/kg	90	5	95
Pesticides	SW5030/8080/8080M	mg/kg	9	1	10
TOTAL SOIL ANALYSES				40	478
TOTAL SOIL SAMPLES			133	8	142

M Modified.

TABLE 2-5. ANALYTICAL METHODS AND TOTAL NUMBER OF WATER ANALYSES

WATER ANALYSES	ANALYTICAL METHOD	REPORTING UNITS	NUMBER OF ANALYSES	TRIP BLANKS	AMBIENT CONDITION BLANKS	EQUIPMENT BLANKS	DUPLICATES	TOTAL ANALYSES
Volatile Organics	SW5030/8260	µg/L	14	9	2	5	3	33
Semi-Volatile Organics	SW3550/8270	µg/L	14	0	0	2	2	18
Total Metals Analysis –ICP Screen	SW3005/6010	µg/L	11	0	0	2	1	14
Dissolved Metals Analysis –ICP Screen	SW3005/6010	µg/L	10	0	0	1	1	12
TOC, Nonpurgable	SW9060	µg/L	11	0	0	0	2	13
Residue, Filterable (TSS)	E 160.2	µg/L	12	0	0	0	2	14
Residue, Filterable (TDS)	E 160.1	µg/L	12	0	0	0	2	14
TPH - Diesel Range	SW3510/3550/8100M	µg/L	13	0	0	5	3	21
TPH - Gasoline Range	SW5030/8015M	µg/L	9	3	0	4	2	18
TPH - Residual Oil	SW3510/3550/8100M	µg/L	13	0	0	4	3	20
BTEX	SW5030/8020/8020M	µg/L	9	4	0	4	2	19
Halogenated Volatile Organic Compounds	SW5030/8010M	µg/L	2	2	0	2	0	6
PCB	SW5030/8080/8080M	µg/L	10	0	3	4	1	18
Pesticides	SW5030/8080/8080M	µg/L	9	0	0	3	1	13
TOTAL WATER ANALYSES			149	18	5	36	25	233
TOTAL WATER SAMPLES			17	10	2	9	3	41

Analytical methods used during sample analyses for this project are summarized in Tables 2-4 and 2-5 and are developed from the reference methods described in the following sources:

- *Test Methods for Evaluating Solid Waste (Physical/Chemical Methods)* Third Edition, EPA SW-846. September 1986.

- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020. March 1983.

- *Standard Methods for the Examination of Water and Wastewater*, APHA/AWWA, 17th Edition. 1989.

- *Interim guidance for Non-UST Soil Cleanups Levels*, Alaska Department of Environmental Conservtion, July 1991.

- *Total Petroleum Hydrocarbons Analytical Methods for Soil and Water*, Washington State Department of Ecology. April 1992.

Project-specific analytical methods and procedures, target analytes, quantitation limits, and acceptance criteria are presented in the RI/FS SAP (U.S. Air Force 1993b).

2.3.4 Chronology of Laboratory Analyses

Laboratory analyses conducted by the temporary laboratory, F&B, in Barrow, Alaska, were conducted on a quick-turnaround basis. The samples collected at Cape Lisburne radar installation were analyzed by this laboratory between 31 August and 13 September 1993.

Analyses at the CT&E laboratory in Anchorage, Alaska, were conducted between 01 September 1993 and 12 July 1995. These analyses included a few quick-turnaround analyses but were primarily standard-turnaround analyses.

2.3.5 Laboratory QA/QC Programs

The QA objectives for this project were achieved through implementation of specific procedures for sampling, chain-of-custody, calibration, laboratory analyses, data validation and reporting, internal QC 6, audits, preventive maintenance, and corrective actions.

A detailed description of QA/QC measures, frequency, and corrective actions used by both laboratories is presented in the Quality Assurance Project Plan (QAPjP) (Section 1.0 of the RI/FS SAP [U.S. Air Force 1993b]). Ultimately, the relevant laboratory standard operating procedures (SOPs) provide full and detailed guidance regarding all method-specific laboratory QA/QC criteria and appropriate corrective actions.

Data quality for the organic analyses was monitored by the laboratory through a QA program that included analyses of initial and continuing calibrations, method blanks, surrogate spikes, internal

standards, matrix spikes and matrix spike duplicates, and laboratory control samples. The identification of target analytes at levels above the detection limit was confirmed by gas chromatography/mass spectrometry (GC/MS) or analysis on a GC equipped with a different column (second column confirmation).

Data quality for the inorganic analyses was monitored through a QC program that included analyses of initial and continuing calibrations, laboratory control samples, method blanks, duplicate samples, post-digestion analytical spikes, and matrix spikes.

Laboratory QC samples were analyzed at a rate of at least one per 20 determinations. See the RI/FS QAPjP for laboratory-specific criteria for the frequency of QC sample analyses and corrective actions regarding QC analyses.

2.3.6 Data Validation and Reporting

Data validation is a systematic process of reviewing a group of sample data to provide assurance that the data are adequate for their intended use. The validation activities were performed in accordance with the following EPA documents to the extent that they were applicable:

- *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses*. EPA. Hazardous Site Evaluation Division. December 1990.
- *Laboratory Data Validation Guidelines for Evaluating Inorganic Analyses*. EPA. Hazardous Site Evaluation Division. October 1989a.
- *Test Methods for Evaluating Solid Waste (Physical/Chemical Methods)*. Third Edition, EPA SW-846. September 1986.

Prior to releasing data for use by project staff, selected data packages underwent a formal validation procedure to examine laboratory compliance with QA requirements and other factors that determine the quality of the data. The organic validation was performed by the prime contractor in accordance with the EPA Functional Guidelines for Evaluating Organic Analyses. The following factors were examined:

- Sample holding times;
- Sample chain-of-custody;
- GC/MS tuning criteria;
- Initial and continuing calibration;
- Method blanks;
- Practical quantitation limits;
- Laboratory blank contamination;
- Surrogate spike recoveries;
- Matrix spike/duplicate analysis;
- Field duplicate analysis;
- Ambient condition blank contamination;
- Trip blank contamination;

- Internal standard area;
- Pesticide instrument performance;
- compound identification criteria; and
- Analyte identification and quantitation.

The inorganic data validation was performed in accordance with the EPA Functional Guidelines for Evaluating Inorganic Analyses. Parameters evaluated include:

- Holding time;
- Blank results;
- Instrument calibration;
- Inductively Coupled Plasma (ICP) Spectroscopy Interference check analysis;
- Laboratory Control Samples;
- Duplicate analyses;
- Spike analyses;
- Furnace analyses (spikes and duplicates);
- Serial dilution;
- Detection limits; and
- Analyte quantitation.

When a data package was received from the laboratory, the analytical results and associated QA/QC documentation were reviewed for technical compliance, and data validation reports were prepared summarizing the QA/QC parameters. All laboratory and field blank sample data were reported, and the data were reviewed by accuracy, precision, and completeness.

A cross-section of CT&E analytical data, representing approximately 15 percent of all the CT&E analyses, underwent formal data validation. Because some reporting errors were found the F&B analytical data, 100 percent of the F&B data was validated. Once the validation for a batch of samples was completed, a validation report was prepared. The report highlights all the QC criteria evaluated, and note any major deficiencies or QA problems. Although a minimal amount of analytical data was rejected during data evaluation, the acceptable and valid data from CT&E and F&B are sufficient to meet the project objectives. The data validation reports for data generated by CT&E and F&B are presented in Appendix G.

2.4 METHODOLOGY FOR RISK ESTIMATION

This section describes the methods used to determine the potential risks to human ecological receptors from chemical detected in samples collected from the sites at the installation. A summary of the risks posed by chemicals detected at each of the sites is presented on a site-by-site basis in Sections 3.0 and 4.0. The complete human health and ecological risk assessments are presented in the Cape Lisburne Risk Assessment (U.S. Air Force 1996), which has been submitted under separate cover.

In addition to the methods for risk evaluation, this section presents contaminant fate and transport, general potential migration pathways, and receptor groups common to all of the five Cape Lisburne sites.

2.4.1 Human Health Risk

The evaluation of human health risk was conducted in accordance with standard risk assessment methodology as described in *Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual, Part A* (EPA 1989b), Region 10 Supplemental Risk Assessment Guidance for Superfund (EPA 1991a), and the *Handbook to Support the Installation Restoration Program Statements on Work* (U.S. Air Force 1991). This section presents a summary of the approach used in evaluating the human health risks associated with the sites at the Cape Lisburne radar installation.

The Cape Lisburne installation presented a unique challenge to the development of a human health risk assessment. Many of the conventional assumptions applied to risk assessments do not apply to the North Slope of Alaska. Cape Lisburne is remote and sparsely populated. Native residents from surrounding areas largely Inupiats, follow a lifestyle that includes a significant subsistence component; much of their food consists of mammals (whales, seals, and caribou), aquatic life (Arctic char), and birds (ptarmigan, ducks) that are abundant in this area of the Arctic. The climate is generally harsh, and the soil and surface water are frozen for approximately nine months of the year. The following paragraphs present some of the approaches and assumptions used in the development of the human health risk assessment.

The general approach to the human health risk assessment was to quantify the excess lifetime cancer risk and the noncancer hazard associated with exposure to the site contaminants detected at each of the five sites at the installation. The maximum concentration of each chemical detected is used at the exposure point concentration instead of arithmetic mean or 95th percentile upper confidence limit (UCL) because contamination was infrequently detected and found to be generally of low concentration. Incorporating nondetects into the calculation of an average of UCL when the frequency of positive detects is low tends to yield low and unreliable estimate of contamination. Use of the maximum concentration yields a more conservative estimate of risk or hazard.

Chemical concentrations detected in soil/sediment and surface water samples from each of the sites were compared to risk-based screening levels (RBSLs), ARARs, and background concentrations. A chemical was selected as a COC if the maximum concentration at which the chemical was detected exceeded the corresponding background concentration, and the RBSL (based either on cancer risk or noncancer hazard) or an ARAR. COCs selected in this manner were evaluated in the human health risk assessment.

An exposure pathway describes the course a chemical will take from a source to an exposure point where a receptor can come into contact with the chemical. The exposure pathways by which exposure to COCs at Cape Lisburne may occur include ingestion, dermal contact, and inhalation. The dermal contact and inhalation pathways were not considered complete or significant because the arctic climate precludes dermal contact with the volatilization of the site

contaminants, so they were not evaluated in the risk assessment. Exposure pathways that were considered for all sites were incidental ingestion of soil/sediment and ingestion of surface water.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to a radar installation (worker), an adult inhabitant of a community in the North Slope Alaska (native), and a child living in a North Slope community (child).

The risk assessment assumed a residential scenario when estimating the soil/sediment and water ingestion rates. The soil/sediment ingestion rate was based on EPA default values, 100 mg/day for adults and 200 mg/day for children. The drinking water ingestion rate assumed that surface water were chemical were detected at the site will be used as a source of drinking water for 180 days per year at the EPA default ingestion rate of 2 liters per day.

The exposure duration assumed a radar installation worker would be stationed at the Cape Lisburne installation for 10 years. The exposure duration for the native was estimated to be 55 years. EPA's default reasonable maximum exposure duration is 30 years; however, this is based on the residence time in one location for the continental United States. Because Alaskan natives are more likely to remain in North Slope communities for a longer period, 55 years was determined to be a more appropriate estimate of residence time.

The risk assessment was based on the assumption above, along with chemical-specific toxicity data, to quantitatively and qualitatively express the hazards and risks. To characterize potential noncancerous effects, comparisons were made between projected intakes of substances and chemical-specific toxicity values. The potential noncancerous health effects were expressed as a hazard quotient (HQ). To assess the overall potential for noncancerous effects posed by more than one chemical at a site, the HQs were summed and reported as the hazard index. An HQ or hazard index of 1.0 is considered the regulatory benchmark. Noncancer hazards greater than 1.0 are generally considered a concern; and noncancer hazards of less than 1.0 are generally considered not to warrant further evaluation.

To characterize the potential for carcinogenic effects, the probability that in individual will develop cancer over a lifetime of exposure, the risks were estimated form projected intakes of the COCs and chemical-specific dose-response information. The cancer risks are calculated on a chemical-specific basis and are added together (if more than one chemical associated with cancer risk is a COC at the site) to estimate the total cancer risk for the site. The total cancer risk for each pathway is generally not considered to be of concern unless it exceeds a value of 1×10^{-6}.

Excess lifetime cancer risk is the incremental increase over the above the background (i.e., of no exposure to site chemical occurs) in the probability of developing cancer during one's lifetime. For example, a 1×10^{-6} excess lifetime cancer risk means that, in a population of 1 million people exposed to the carcinogen throughout their lifetimes, the average incidence of cancer may increase by one case. The background probability among Americans of developing cancer at some time in their lives is about one in four (American Cancer Society 1993). The calculation of cancer risks uses information (i.e., cancer slope factors) developed by the EPA that represents upper bound estimates, so any cancer risks estimated in the risk assessment should be regarded

a upper bounds rather than accurate representations; the true cancer risk is likely to be lower than that predicted (EPA 1989a).

Excess lifetime cancer risk and non cancer hazard were calculated for the soil/sediment ingestion and water ingestion pathways. Other pathways were eliminated from consideration as described in the Cape Lisburne Risk Assessment (U.S. Air Force 1996). The risks and hazards associated with chemicals detected at the Cape Lisburne sites are presented on a site-by-site basis in Section 4.0 of this RI/FS report.

2.4.2 Ecological Risk

The objective of the ERA was to estimate potential impacts to aquatic and terrestrial plants and animals at the Cape Lisburne radar installation. The evaluation of environmental risks was conducted in accordance with the current Air Force and EPA guidance, specifically, *Handbook to Support the Installation Restoration Program Statements of Work* (U.S. Air Force 1991), *Framework for Ecological Risk Assessment* (EPA 1992), and *Ecological Risk Assessment Guidance for Superfund* (EPA 1994).

The approach used to assess potential ecological impacts were conceptually similar to that used to assess human health risks; potentially exposed populations (receptors) were identified, and information on exposure and toxicity was combined to derive estimates of risk. However, the scope of ERAs is generally different from that of human health risk assessments in that ecological assessments focuses on potential impacts to a population of organisms rather than to individual organisms (except in the case of endangered species were individuals are considered). In addition, because ecosystems are composed of a variety of species, ecological assessments evaluate potential impacts to numerous species instead of a single species (as in the case in human health assessments).

Ideally, ERAs should evaluate potential risks to communities and ecosystems, as well as to individual populations. However, because of the large number of species and communities present in natural systems, such ecosystem-wide assessments are very complex and appropriate assessment methodologies have not yet been developed. In addition, dose-response data on community or ecosystem responses are generally lacking. Therefore evaluations of potential impacts to communities or ecosystems are qualitative.

The degree to which potential ecological impacts can be characterized is highly dependant upon the data available to support such estimates. Data required include: information regarding contaminant release, transport, and fate; characteristics of potential receptor populations; and adequate supporting toxicity data for the COCs. The degree to which the existing database can meet these requirements dictates the extent to which potential ecological impacts can be evaluated.

Ecological receptors can be exposed to COCs through abiotic and biotic media. Potential exposure pathways for terrestrial and aquatic organisms include direct contact and ingestion of contaminated soil/sediment and/or surface water. The most significant route of exposure for plants is direct contact with soil. Aquatic organisms such as fish and invertebrates are primarily

exposed through direct contact with surface water, but may be exposed to COCs thorough foraging (only direct contact with surface water is used to develop risk estimates). Birds and mammals may be exposed to COCs through ingestion of surface water, ingestion of plant and animal diet items, and incidental ingestion of soil/sediment.

The potential ecological receptors evaluated in the risk assessment include plants, aquatic organisms, birds, and mammals likely to occur along the Arctic Coastal Plain. Representative species from these groups of receptors were selected based primarily on the species' likelihood of exposure considering their preferred habitat and feeding habits. Species that may be particularly sensitive to environmental impacts, such as endangered or threatened species, were also evaluated. The representative species are presented in Table 2-6.

Potential risks to representative species were estimated by evaluating sampling data for the relevant exposure media (i.e., soil/sediment and surface water). Potential risks to plants were evaluated by comparing the contaminant concentrations in the site soil/sediments to toxicity information in the literature. Potential impacts to aquatic receptors were evaluated by comparing average surface water concentrations to toxicity reference values (TRVs). Potential impacts to birds and mammals were evaluated for selected representative species bases on comparisons of estimated exposure to TRVs. TRVs for representative species were derived by selecting toxicity values from the literature and extrapolating to the species of concern. TRVs were then divided into the estimated exposure concentration to derive the HQ. If the HQ is less than one, then adverse effects are not expected. Conversely, if the HQ is equal to or greater than one a potential for adverse effects exists.

The ERA was intended to be at a screening level, rather than a full scale investigation of the state of the ecosystem. No specific onsite studies of the biota were undertaken. The assessment was based on media sampling (i.e., surface water and soil/sediment samples). The ecological risks associated with the chemicals detected at the Cape Lisburne sites are presented in Section 4.0 of this RI/FS report. The complete ERA is presented in the Section 3.0 of the Cape Lisburne Risk Assessment (U.S. Air Force 1996).

2.4.3 Contaminant Fate and Transport

The fate and transport of the COCs in soil/sediment and surface water have been accounted for in the sampling plan. Known source areas were sampled, and the extent of migration was evaluated by sampling at increasing distances from the source area. Surface and subsurface sampling was conducted in gravel pads and tundra areas to characterize the extent of contaminant migration. Ground water was not evaluated because subsurface water flow occurs only in the active layer over the permafrost, and ground water is not used for domestic purposes. Surface water samples were collected in streams and ponds and analyzed to evaluate the migration of contamination from source areas to water bodies potentially used by human or ecological receptors. The potential contaminant migration is discussed in a site-specific basis in Section 4.0.

TABLE 2-6. REPRESENTATIVE SPECIES

COMMON NAME	GENUS AND SPECIES
Sedge	Carex spp.
Cottongrass	Eriophorum spp.
Willow	Salix spp.
Berries	Vaccinium spp.
Water fleas	Daphnia spp.
Nine-spined stickleback	Pungitius pungitius
Arctic char	Salvelinus alpinus
Lapland longspur	Calcarius lapponicus
Brant	Branta bernicla
Glaucous gull	Larus hyperboreus
Pectoral sandpiper	Calidris melanotos
Brown lemming	Lemmus trimucronatus
Arctic Fox	Alopex lagopus
Barren-ground caribou	Rangifer tarandus

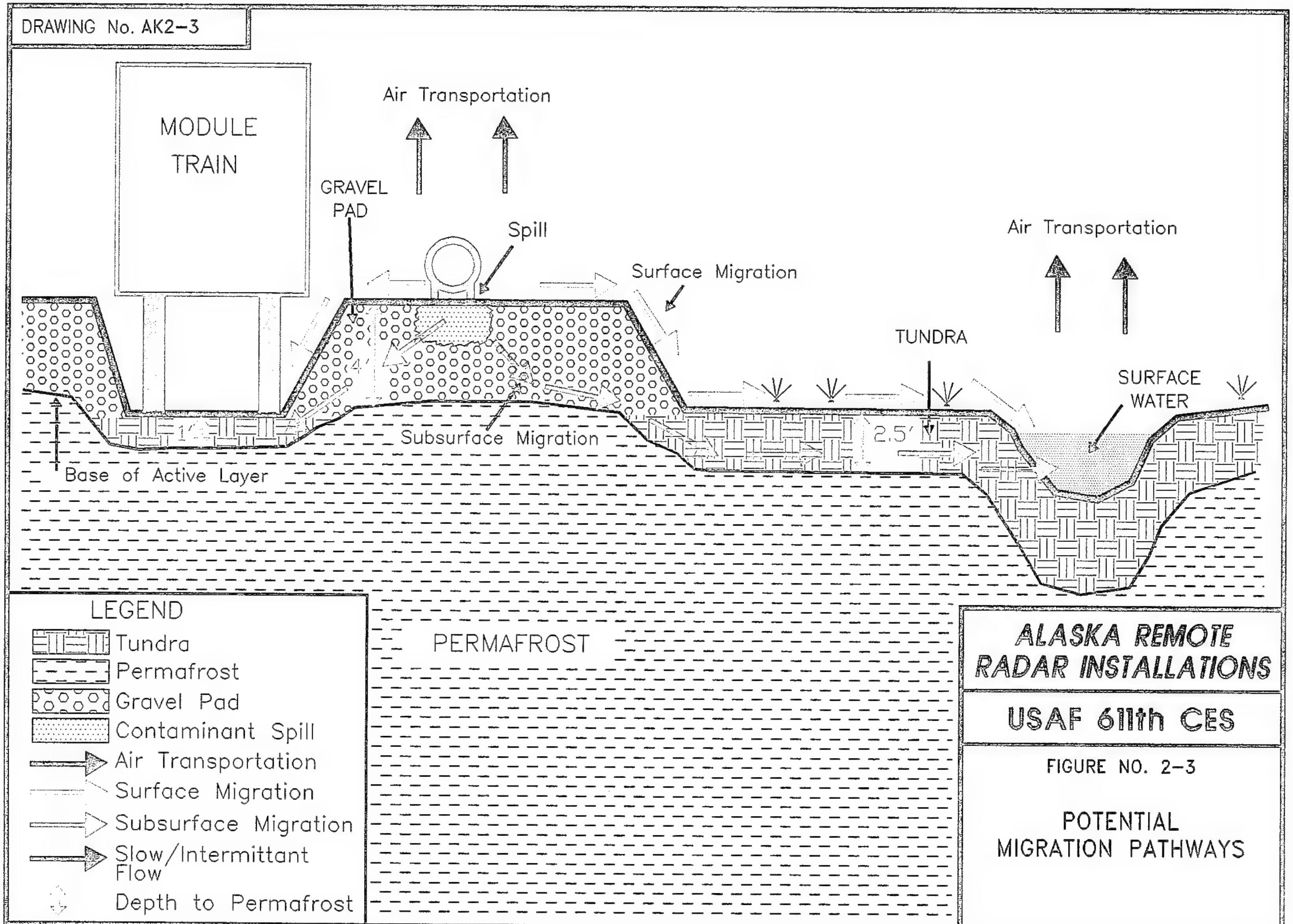
2.4.4 General Migration Pathways

This section presents general information concerning migration pathways for the five sites at the Cape Lisburne radar installation. Site-specific migration pathways are presented in Section 4.0.

The potential for contaminant migration exists for any site where a release has occurred. The threat that a contaminated site presents to human health or the environment was assessed according to the potential for contaminant migration, appropriate human or ecological receptors, and contaminant concentrations to which the receptors may be exposed.

There are three main pathways through which contaminants may reach human and ecological receptors. These pathways are subsurface migration (in affected active layer water), surface migration, and air transportation (as vapors or dust). Potential migration pathways are depicted in Figure 2-3. Figures 2-4 and 2-5 present the potential exposure pathways for the human and ecological receptors, respectively. The discussion of migration pathways is preceded by a general description of the topography and stratigraphy at Cape Lisburne.

THIS PAGE INTENTIONALLY LEFT BLANK



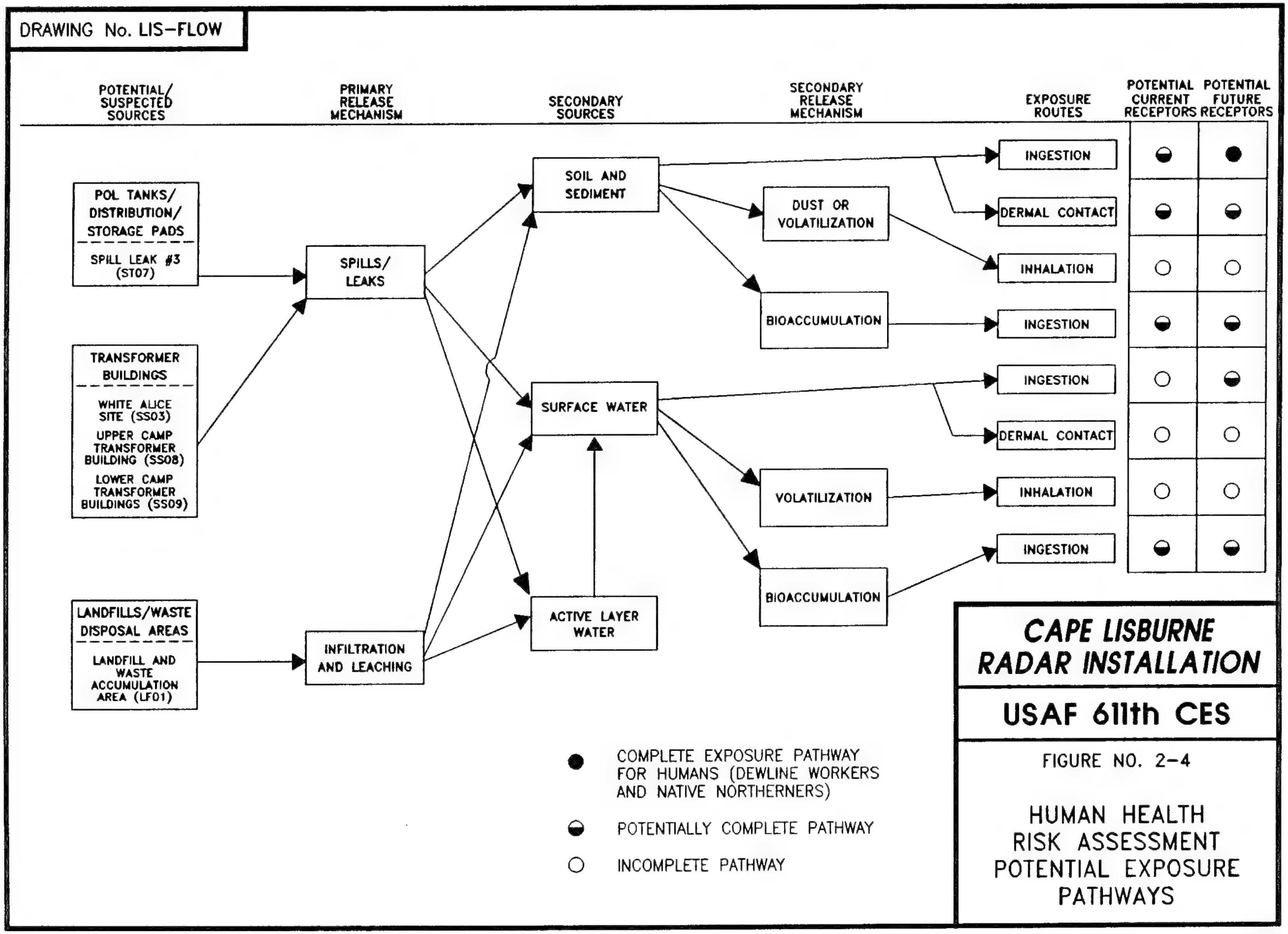
ALASKA REMOTE RADAR INSTALLATIONS

USAF 611th CES

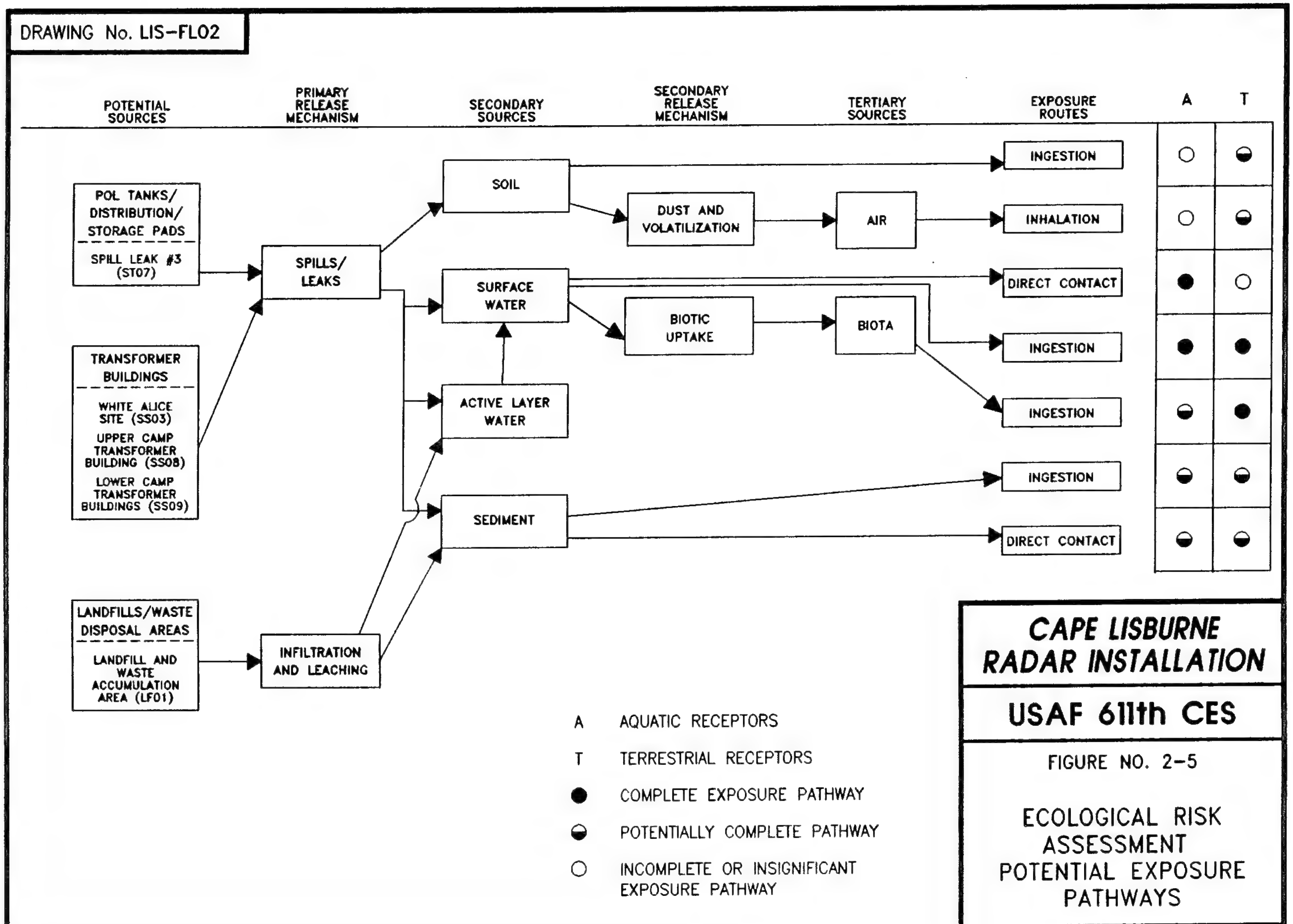
FIGURE NO. 2-3

POTENTIAL MIGRATION PATHWAYS

THIS PAGE INTENTIONALLY LEFT BLANK


DRAWING No. LIS-FLOW
POTENTIAL/ SUSPECTED SOURCES
PRIMARY RELEASE MECHANISM
SECONDARY SOURCES
SECONDARY RELEASE MECHANISM
EXPOSURE ROUTES
POTENTIAL CURRENT RECEPTORS
POTENTIAL FUTURE RECEPTORS
POL TANKS/ DISTRIBUTION/ STORAGE PADS
SPILL LEAK #3 (ST07)
TRANSFORMER BUILDINGS
WHITE ALICE SITE (SS03)
UPPER CAMP TRANSFORMER BUILDING (SS08)
LOWER CAMP TRANSFORMER BUILDINGS (SS09)
LANDFILLS/WASTE DISPOSAL AREAS
LANDFILL AND WASTE ACCUMULATION AREA (LF01)
SPILLS/ LEAKS
INFILTRATION AND LEACHING
SOIL AND SEDIMENT
SURFACE WATER
ACTIVE LAYER WATER
DUST OR VOLATILIZATION
BIOACCUMULATION
VOLATILIZATION
BIOACCUMULATION
INGESTION
DERMAL CONTACT
INHALATION
INGESTION
INGESTION
DERMAL CONTACT
INHALATION
INGESTION
COMPLETE EXPOSURE PATHWAY FOR HUMANS (DEWLINE WORKERS AND NATIVE NORTHERNERS)
POTENTIALLY COMPLETE PATHWAY
INCOMPLETE PATHWAY
CAPE LISBURNE RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-4
HUMAN HEALTH RISK ASSESSMENT POTENTIAL EXPOSURE PATHWAYS

THIS PAGE INTENTIONALLY LEFT BLANK


DRAWING No. LIS-FL02
POTENTIAL SOURCES
PRIMARY RELEASE MECHANISM
SECONDARY SOURCES
SECONDARY RELEASE MECHANISM
TERTIARY SOURCES
EXPOSURE ROUTES
A
T
POL TANKS/ DISTRIBUTION/ STORAGE PADS
SPILL LEAK #3 (ST07)
TRANSFORMER BUILDINGS
WHITE ALICE SITE (SS03)
UPPER CAMP TRANSFORMER BUILDING (SS08)
LOWER CAMP TRANSFORMER BUILDINGS (SS09)
LANDFILLS/WASTE DISPOSAL AREAS
LANDFILL AND WASTE ACCUMULATION AREA (LF01)
SPILLS/ LEAKS
INFILTRATION AND LEACHING
SOIL
SURFACE WATER
ACTIVE LAYER WATER
SEDIMENT
DUST AND VOLATILIZATION
BIOTIC UPTAKE
AIR
BIOTA
INGESTION
INHALATION
DIRECT CONTACT
INGESTION
INGESTION
INGESTION
DIRECT CONTACT
A AQUATIC RECEPTORS
T TERRESTRIAL RECEPTORS
COMPLETE EXPOSURE PATHWAY
POTENTIALLY COMPLETE PATHWAY
INCOMPLETE OR INSIGNIFICANT EXPOSURE PATHWAY
CAPE LISBURNE RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-5
ECOLOGICAL RISK ASSESSMENT POTENTIAL EXPOSURE PATHWAYS

THIS PAGE INTENTIONALLY LEFT BLANK

2.4.4.1 Topography. The Cape Lisburne installation is located on the north shore of Cape Lisburne, where the Brooks Range, Lisburne Hills, meets the Chukchi Sea. The installation is located in a small valley between mountains, in the proximity of Selin Creek. The installation consists of a Lower Camp located near the shoreline and Upper Camp located on the top of an adjacent mountain. The Lower Camp consists of functional and abandoned buildings, various facilities, and a landing strip, with most installation facilities clustered at approximately 50 feet above mean sea level (MSL). The Upper Camp consists of a radar dome (radome), associated support facilities, and various abandoned buildings and communication facilities. The Upper Camp is located on top of a mountain at an elevation of approximately 1,500 feet above MSL. Access to the Upper Camp from the Lower Camp is provided by a 3.9 mile gravel road.

The land surface near the eastern portion of the Lower Camp is relatively flat, with the topography gradually rising to the south at an approximately 4.5 degree slope; the land surface near the western portion of the Lower Camp is provided by streams and drainage features, with Selin Creek having incised approximately 15 feet into the surrounding topography. Selin Creek flows along the east side of the cluster of station facilities and is the most prominent drainage feature in the area. Other prominent water bodies and drainage features at the Lower Camp include a man-made drainage ditch located along the southern and eastern edges of the runway and a small lake with an outlet stream adjacent to the east side of Old Landfill (LF01). Relatively steep slopes are also located near the shoreline with the Chukchi Sea, beach bluffs up to approximately 20 feet high mark the transition from tundra to beach at these locations. Upper Camp facilities are located on top of a rocky, barren mountain. The mountain has steep sides and has no obvious drainage features in the vicinity of the Upper Camp.

2.4.4.2 Stratigraphy. The stratigraphy at Cape Lisburne was examined during RI activities down to the level of the permafrost (generally no deeper than six feet). The upper-most features at the Lower Camp are gravel roads and pads of human origin. These features, which are limited in areal extent, have a maximum height of approximately six feet. They generally consist of well-sorted sandy gravels with sub-angular to sub-rounded, very fine to coarse sands and sub-angular to sub-rounded gravel clasts ranging from one-quarter inch to one and one-half inches (although gravel clasts ranging up to four inches or more are occasionally encountered). The grains are unconsolidated, and fine material (silts or clays) may be present in minor quantities. The depth to permafrost under gravel pads and roads ranged from five to seven feet during August and September 1993.

Gravel pads and roads were constructed on top of native tundra, which occurs throughout the Lower Camp. The top several inches of the tundra consists of a vegetative mat in a loamy/silty matrix. Underlying the tundra map are find to coarse sands and gravels, dark brown organic clays, and silt layers. The depth to permafrost beneath the tundra was approximately two feet during August and September 1993. Adjacent to the ocean, beaches that consists of poor to well sorted, sub-rounded to rounded, fine to coarse sand and gravel with minor amounts of fine material may be present.

There has been a general lack of soil formation in the area surrounding the Upper Camp, and the ground surface consists of loose rocks and gravel in a sandy silt matrix. In areas of the

Upper Camp where the stratigraphy was examined at depth, bedrock was located at a depth of two feet.

2.4.4.3 Subsurface Migration. Active layer water flow under the tundra is hampered by the presence of numerous wet depressions; because the depth to permafrost under these depressions is increased they tend to act as small catchment basins. These basins limit the potential for the horizontal flow of active layer water (Miller et al. 1980; Robertson 1988). The active layer water flow in these areas is so inhibited that it contributes little to the midsummer water budget of tundra streams; most of the active layer water contribution to these streams is from well-drained slopes immediately adjacent to the streams (Robertson 1988).

Some generalizations about active layer water flow can be made. Due to the combined effects of relatively low topographic relief (expressed throughout most of the Lower Camp) and the presence of numerous catchment basins, active layer water migration through areas of tundra is a slow process. The active layer water contribution to tundra streams is mainly from well-drained slopes next to those streams. The active layer water flow that does occur is governed by changes in topographic relief and is limited to spring and summer months, with the active layer functioning as a shallow, unconfined aquifer. The water table in such an aquifer tends to mimic topographic features, and active layer water flow is driven by elevation changes. Overall, the topography at the Lower Camp slopes slightly from the south to the north, and active layer water flow can be expected to occur towards the Chukchi Sea. The lack of upgradient source areas at the Upper Camp indicates that active layer water in this area is the result of direct precipitation and that the active layer water flux is relatively minor. The lack of a significant soil horizon (bedrock is near the surface) suggests that there is relatively little active layer water held in storage.

2.4.4.4 Surface Migration. Surface migration at Cape Lisburne may occur as a result of the flow of surface water from topographic highs to topographic lows. Surface water flow during the spring thaw, when mounds of snow can channel drainage in unexpected directions, can be markedly different from flow during the summer months. The general surface migration features and directions are depicted in Figure 1-8.

The main factors controlling surface water flow are the topography and water availability; the water availability remains relatively high throughout the site during the summer months, but the topography is varied. The topography at the Lower Camp has relatively low relief at most of the eastern portion of the site, and there is a correspondingly small gradient with which to drive surface water flow. Combined with the depressions formed by the ice wedge polygons in this area, this creates a multibasinal drainage pattern in which much of the surface water is directed into depressions and small tundra ponds rather than draining directly into drainage channels. The western portion of the Lower Camp has sufficient relief to create reasonably well-drained slopes which do not exhibit a multibasinal drainage pattern. Drainage in this area is probably uniformly towards drainage features and the sea. There are no obvious drainage features at the Upper Camp.

Precipitation in the Cape Lisburne area averages approximately 12 inches per year. Additionally, 65 percent of the precipitation on the North Slope is in the form of snow (Walker et al. 1980).

Most surface water flow occurs during the spring, when melting snow and ice release stored water during a relatively short time-frame and the active layer remains partially frozen. This creates a situation in which there is a large supply of surface water and very little capacity for infiltration. The result is the overload sheet flow of surface water (Robertson 1988). During which drainage is not confined to local drainage features but may travel in a sheet-like fashion over the topography. Snow, ice, and man-made features (gravel pads and roads may result in barriers that force the flow of surface water in directions different from those dictated by the underlying ground surface.

There is comparatively little flow of surface water during the summer. In fact, Arctic wetlands exist because the lack of significant vertical relief retards the horizontal flow of surface water, and permafrost limits downward flow (Robertson 1988). Overflow from tundra ponds is generally dependent upon summer rainfall and spring meltwater.

The major drainage feature in the area is Selin Creek, which originates in the Lisburne Hills and flows past the eastern edge of the main station before entering the Chukchi Sea. Additional drainage features include a ditch that runs along the south and east sides of the airstrip before entering the Chukchi Sea, and a small stream that drains a ponded area along the east side of the Landfill and Waste Accumulation Area (LF01).

2.4.4.5 Air Transport. Air transportation of contaminants is not considered to be a significant migration pathway at Cape Lisburne. The frozen conditions encountered most of the year are not conducive to the volatilization of organic contaminants or to the transport of affected dust and dirt. During the summer months the air and ground temperatures remain relatively low (reducing volatility) and the abundant supply of moisture retards the entrainment of affected dust.

2.4.5 Receptors

Three potential human receptor groups were evaluated for the Cape Lisburne Risk Assessment: an adult assigned to a radar installation (worker), an adult native of the North Slope of Alaska (native), and a native child (child).

The primary routes of human exposure evaluated in the Cape Lisburne Risk Assessment are incidental ingestion of soil and ingestion of surface water.

For the ecological evaluation it was assumed that terrestrial and aquatic species are potential receptors for at least the six months of the year when the region is not ice and snow covered. In addition, it was assumed that species at great distances from the radar installation are not receptors (e.g., whales). Whales may migrate off-shore from the radar installation; it is unlikely, however, that these mammals are potential receptors to COCs released from the sites because of dilution of surface water entering the Arctic Ocean and the distance off-shore that these animals migrate. Potential ecological receptors evaluated in the ERA were discussed in Section 2.4.2.

The potential human health and ecological risks to receptors associated with the contaminants detected at the Cape Lisburne sites are reported on a site-specific basis in Section 4.0.

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 REMEDIAL INVESTIGATION - NO FURTHER ACTION AREA OF CONCERN

This section of the RI/FS presents results from RI sampling and analysis activities for the Water Gallery area of concern number three (AOC3), the one Cape Lisburne area of concern. The Water Gallery is considered for no further action. (Note: the figure and table are presented at the end of the section.) The information presented for the area of concern includes site background, field sampling and analytical results, and conclusions and recommendations. The discussion is intended to provide the reader with all the information needed to support no further action at this area of concern.

Photographs of the Cape Lisburne installation, the sites, and the area of concern investigated during the RI are presented in Appendix B. Data tables in this section list analytical results from samples in which chemicals were detected above quantitation limits. Complete laboratory analytical data sheets for each sample, including quantitation limits for non-detected analytes, are provided in Appendix F.

3.1 WATER GALLERY (AOC3)

3.1.1 Site Background

The Water Gallery (AOC3) is located on Selin Creek, approximately 200 yards east of the main installation, and is the source from which the installation obtains drinking water (Figure 3-1). Selin Creek is a shallow, braided stream with a rocky bed; during the RI the stream contained clear water and had no vegetation in the stream bed. Shallow groundwater wells and a pumphouse are part of the Water Gallery system. The water supply system was investigated because trace amounts of carbon disulfide were reported in a previous water sample (Woodward-Clyde 1992). Sampling and analysis of the Water Gallery (AOC3) was conducted during the RI because the validity of the 1992 data and the presence of carbon disulfide in the water are questionable.

3.1.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the Water Gallery (AOC3). The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

3.1.2.1 Summary of Samples Collected. Five samples were collected from Selin Creek and the Water Gallery system wells and pumphouse. These consisted of one surface water and four ground water samples. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities. Locations of all samples collected at the Water Gallery (AOC3) are presented in Figure 3-1.

The one surface water sample was analyzed for DRPH, RRPH, VOCs (8240), SVOCs, pesticides, PCBs, TOC, TSS, TDS, and total and dissolved metals.

Four ground water samples collected from the Water Gallery (AOC3) were analyzed for SVOCs, pesticides, PCBs, and total and dissolved metals. In addition, three samples were analyzed for VOCs (8260) TOC, TSS, and TDS. One sample was analyzed for VOCs (8240).

3.1.2.2 Analytical Results. The data summary table (Table 3-1) presents analytical results for all samples collected at the area of concern. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow direct comparison of naturally occurring organic compounds and inorganic analytes with samples collected from the area of concern. Sample locations and analytical results for the samples at the Water Gallery (AOC3) are illustrated in Figure 3-1. All organic compounds detected are presented on the figure except when they resulted from laboratory contamination or field decontamination procedures. In addition, only metals detected significantly above background levls that exceed an RBSL or ARAR are presented on Figure 3-1. The exceptions are presented on the data summary table.

The following section presents a discussion of organic compounds and inorganic analytes detected above background levels at the Water Gallery (AOC3). A discussion of TDS, TSS, and TOC is included.

Organics. No organic compound was detected in ground or surface water samples from the area of concern.

Inorganics. Metals concentrations were not a concern at the Water Gallery (AOC3); however, metals detected in ground and surface water samples collected at the area of concern were detected at similar concentrations to background metal concentrations.

TOC was reported at <5,000 µg/L in water. TSS in water were reported ranging from 2,500 to 4,500 µg/L, and TDS were reported ranging from 176,000 to 235,000 µg/L.

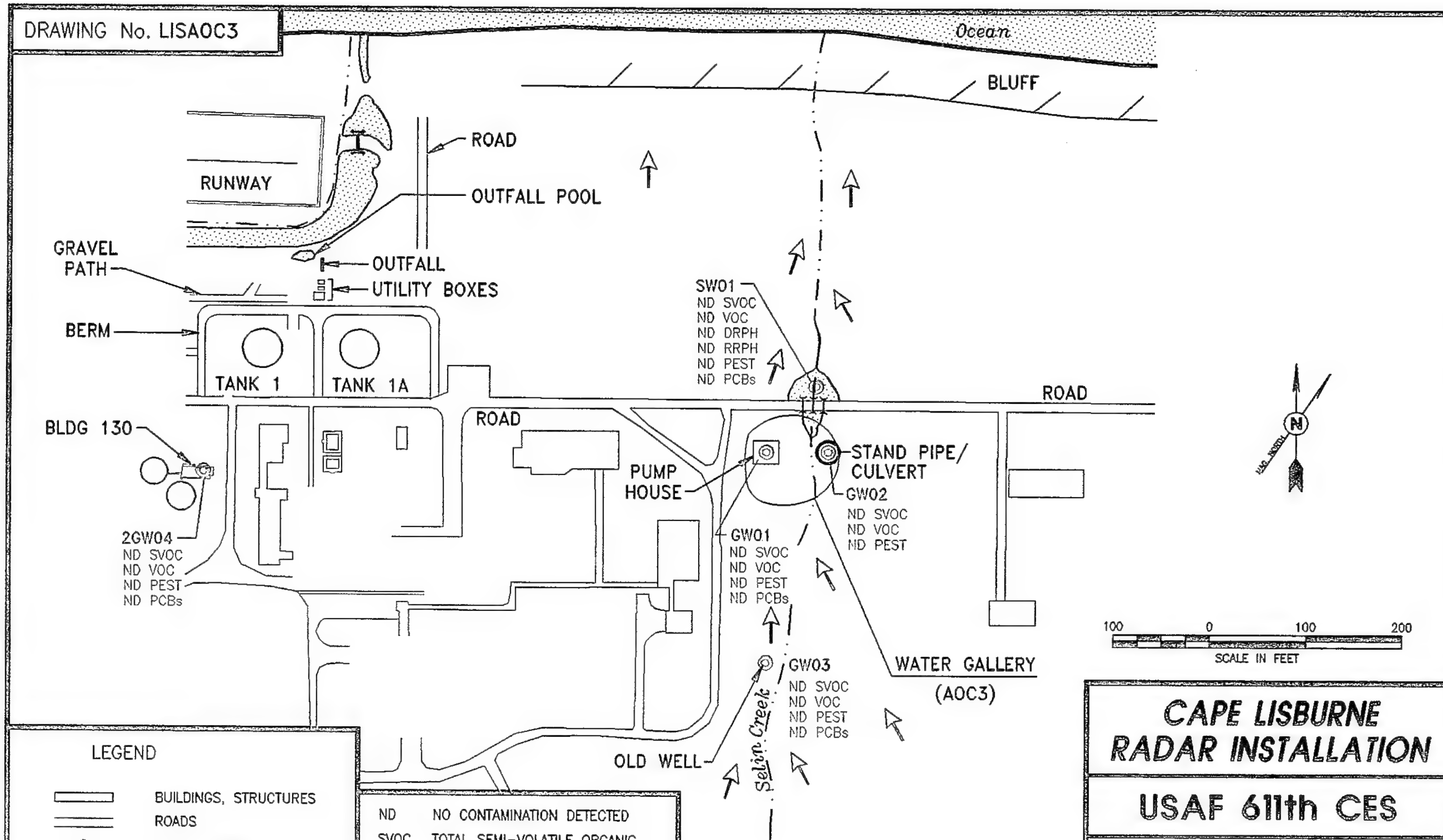
3.1.2.3 Summary of Site Contamination. Previous sampling conducted at the Water Gallery (AOC3) identified carbon disulfide at 0.4 µg/L (Woodward-Clyde 1992). The quality of the previous IRP sampling data is unknown as is the validation that the data have undergone. No organic compounds were detected in surface or ground water samples collected during the more extensive sampling conducted during the RI, which included this previous sampling location.

A comparison of historical and current project data indicates that carbon disulfide is not present in the ground or surface water associated with the Water Gallery (AOC3). The previous detect of 0.4 µg/L in the groundwater was an estimated value detected below the laboratory quantitation limit. The value is probably a false positive due to laboratory contamination or field sampling procedures.

3.1.3 Conclusions and Recommendations

Sampling and analyses have determined that the Water Gallery (AOC3) is not contaminated. No chemicals were detected at the area of concern, and the Water Gallery (AOC3) is recommended for no further action.

THIS PAGE INTENTIONALLY LEFT BLANK



LEGEND

	BUILDINGS, STRUCTURES
	ROADS
	WATER SAMPLE
	SURFACE WATER
	CULVERT
	GRAVEL PAD BOUNDARY
	SURFACE DRAINAGE
2.6 ppm	CT&E DATA
0.9 ppm	F&B DATA

ND	NO CONTAMINATION DETECTED
SVOC	TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
VOC	TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
RRPH	RESIDUAL RANGE PETROLEUM HYDROCARBONS
PEST	PESTICIDES
PCBs	POLYCHLORINATED BIPHENYLS

CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 3-1

WATER GALLERY (AOC3) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 3-1. WATER GALLERY ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne Matrix: Surface/Ground Water
Site: Water Gallery (AOC3) Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks
					SW01	GW01	GW02	GW03	AB01	EB01	TB01	
Laboratory Sample ID Numbers					1380 4477-3 4476-4	1570 4481-1 4477-7 4476-8	1571	1572	4512-3	1558/1561 4476-5	1552 4476-1	#1&2-9493 #6-9393 4476 4481 4477
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	20	200		<1,000[b]	<1,000[b]	NA	NA	NA	NA	<1,000J[b]	NA	NA
RRPH (Approx.)	200	2,000		<2,000	<2,000	NA	NA	NA	NA	<2,000	NA	NA
VOC 8240	1	1-10		<1[c]	<1-<10	<1-<10	<1	<1-<10	<1[c]-13J[c]	<1[c]	<1[c]-1.7[c]	<1
SVOC 8270	10	10-11		<10	<10	<11	<10	<10	NA	<10	NA	<10
Pesticides	0.02-1.0	0.2-10		<0.2J-<10J	<0.2-<10	<0.2J-<10J	<0.2-<10	<0.2J-<10J	NA	<0.2J-<10J	NA	NA
PCBs	0.2	2	0.5	<2J	<2J	<2J	NA	<2J	NA	<2J	NA	NA
TOC	5,000	5,000		<5,000-15,600	<5,000	<5,000	<5,000	<5,000	NA	NA	NA	NA
TSS	100	200		<2,500-3,000	2,500	4,500	4,000	4,000	NA	NA	NA	<200
TDS	10,000	10,000		203,000-245,000	235,000	183,000	176,000	180,000	NA	NA	NA	<10,000

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
c Result determined by 8260 method analysis.

TABLE 3-1. WATER GALLERY ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Water Gallery (AOC3)
Matrix: Ground Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Sample						Field Blanks			Lab Blanks
					2GW04						AB01	2EB04	2TB04	
Laboratory Sample ID Numbers					1928 4727-1						4512-3	1924 4727-10	4727-9	#6-91393 4727
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L	µg/L	µg/L
VOC 8260	1	1		<1	<1J						<1-13J	<1-3.5J	<1-7.0J	<1
SVOC 8270	10	10		<10	<10						NA	NA	NA	<10
Pesticides	0.02-10	0.2-10		<0.2J-<10J	<0.2J-<10J						NA	NA	NA	NA
PCBs	0.2	2	0.5	<2J	<2						NA	NA	NA	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE 3-1. WATER GALLERY ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Water Gallery (AOC3)
Matrix: Surface/Ground Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks		Lab Blanks
					SW01	GW01	GW02	GW03	2GW04	EB01	EB02	
Laboratory Sample ID Numbers					4477-5	4481-1	4481-2 4476-9	4476-10	4727-1	4476-5	4511-2	4476 4477/4481 4511/4727
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	17.4	100		<100 (<100)	<100J (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100J	<100	<100 (<100)	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100	<100	<100 (<100)	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100	<100	<100 (<100)	<100 (<100)
Barium	1.2	50	2,000	79-92 (73-89)	100 (100)	87 (85)	130 (120)	92 (90)	73	<50	<50 (<50)	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Calcium	34.5	200		28,000-41,000 (28,000-41,000)	41,000 (41,000)	41,000 (41,000)	41,000 (41,000)	43,000 (42,000)	32,000	210	<200 (<200)	<200 (<200)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Cobalt	N/A	50-100		<100 (<100)	<100 (<100)	<100 (<100)	<50 (<100)	<100 (<100)	<100	<100	<100 (<100)	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Iron	25.0	100		<100 (<100)	120 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100J	110	<100 (<100)	<100 (<100)

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE 3-1. WATER GALLERY ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Water Gallery (AOC3)
Matrix: Surface/Ground Water
Units: µg/L
METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks		Lab Blanks
					SW01	GW01	GW02	GW03	2GW04	EB01	EB02	
Laboratory Sample ID Numbers					4477-5	4481-1	4481-2 4476-9	4476-10	4727-1	4476-5	4511-2	4476 4477/4481 4511/4727
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Lead	6.6	100	15	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100	<100	<100 (<100)	<100 (<100)
Magnesium	47.8	200		4,500-9,000 (4,500-8,800)	8,900 (8,900)	8,400 (8,400)	8,700 (8,400)	9,300 (8,800)	7,000	<200	<200 (<200)	<200 (<200)
Manganese	1.24	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)
Potassium	1,154.3	5,000		<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000	<5,000	<5,000 (<5,000)	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100	<100	<100 (<100)	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50J (<50J)	<50 (<50)
Sodium	27.7	250		4,000-5,600 (3,900-6,000)	4,400 (4,600)	5,100 (5,300)	5,000 (5,300)	5,300 (4,600)	4,800	360	340 (380)	<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)	<5	<5	<5 (<5)	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50	<50	<50 (<50)	<50 (<50)

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE 3-1. WATER GALLERY ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Water Gallery (AOC3)

Matrix: Surface/Ground Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks		Lab Blanks
					SW01	GW01	GW02	GW03	2GW04	EB01	EB02	
Laboratory Sample ID Numbers					4477-5	4481-1	4481-2 4476-9	4476-10	4727-1	4476-5	4511-2	4476 4477/4481 4511/4727
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Zinc	8.2	50		<20-260 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	190	<50	<50 (<50)	<50 (<50)

☐ CT&E Data.
N/A Not available.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 REMEDIAL INVESTIGATION - REMEDIAL ACTION SITES

This section of the RI/FS presents results from RI sampling and analysis activities for each of the five Cape Lisburne sites where remedial action may be warranted. The five sites considered for remedial action and discussed in this section are the Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Spill/Leak #3 (ST07), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). Each of the sites is presented individually in Sections 4.1 through 4.5. (Note: figures and tables are presented at the end of each section.) The information presented for each site includes site background, field sampling and analytical results, potential migration pathways, human health and ecological risk assessment summaries, and conclusions and recommendations. The site-by-site discussions in this section are intended to provide the reader with all information needed to understand the site conditions and make decisions regarding appropriate action for each of the sites.

Photographs of the Cape Lisburne installation and the sites investigated during the RI are presented in Appendix B. Data tables in this section list analytical results from samples in which chemicals were detected above quantitation limits. Complete laboratory analytical data sheets for each sample, including quantitation limits for non-detected analytes, are provided in Appendix F.

4.1 LANDFILL AND WASTE ACCUMULATION AREA (LF01)

4.1.1 Site Background

The Landfill and Waste Accumulation Area (LF01) site consists of three contiguous areas east of the runway and adjacent to the Chukchi Sea. The site is covered by gravel on the east and tundra on the west. Two small gravel areas (gravel covered areas #1 and #2) are located in the middle of the tundra-covered section adjacent to the road, and north of the beacon facility. The site was reportedly used to store waste oils, paints, solvents and diesel fuels, empty drums, discarded vehicles, and scrap metal. In 1977 to 1978 a general cleanup was performed, which included burial of empty drums and other debris, and off-site shipment of drums containing liquid wastes.

RI sampling and analyses detected VOCs, BTEX, GRPH, DRPH, and RRPH; concentrations of BTEX, DRPH, and RRPH were above action levels. A sludge pile/buried drum area was identified during the RI on the west side of the landfill, approximately 50 feet north of the gravel road. The sludge pile/buried drum area covered approximately 200 square feet. Sampling and analyses during the RI indicated that contaminants were migrating from this area towards the Chukchi Sea. The sludge pile/buried drum area was excavated as part of IRA in September 1994 and May 1995. Excavated materials are temporarily stored in an onsite containment cell. Sampling and analyses conducted on soils from the sludge pile/buried drum area and containment cell are discussed in the Cape Lisburne IRA Report (U.S. Air Force 1995).

Previous sampling, conducted in 1992 by Air Force contractors, detected PCBs, VOCs, SVOCs, and metals in soil/sediment. A detailed list of contaminants, source areas, and concentrations previously detected is presented in the RI/FS Work Plan (U.S. Air Force 1993a).

The site-specific environmental setting describing the topography, surface water drainage, and soil types is presented in the discussion of potential migration pathways, Section 4.1.3.

4.1.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the Landfill and Waste Accumulation Area (LF01) site. The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

4.1.2.1 Summary of Samples Collected. A total of 55 samples was collected from gravel pads, tundra areas, ponds, and streams at the site. These consisted of 23 soil, 21 sediment, 3 ocean sediment, and 8 surface water samples. In addition, 29 samples were collected for field screening for PCBs. Six of the field screening samples were analyzed by the laboratory for confirmation of the results. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities and further RI characterization conducted in 1994 and 1995. Locations of all samples collected at the Landfill and Waste Accumulation Area (LF01) are presented in Figures 4-1 and 4-2.

Twenty-one soil samples were analyzed for PCBs. In addition, eleven samples were analyzed for GRPH. Ten samples were analyzed for DRPH and RRPH. Six samples were analyzed for BTEX, HVOCs, and VOCs, and five samples were analyzed for SVOCs. Two samples were analyzed for metals, and one sample was analyzed for pesticides.

Seventeen sediment samples were analyzed for PCBs. In addition, eleven samples were analyzed for GRPH. Nine samples were analyzed for DRPH and RRPH. Seven samples were analyzed for BTEX and HVOC, and six samples were analyzed for VOCs and SVOC. Two samples were analyzed for metals.

Three ocean sediment samples were collected approximately 100 yards offshore and were analyzed for PCBs.

Eight surface water samples were analyzed for DRPH and RRPH. Six of these samples also were analyzed for GRPH, BTEX, HVOCs SVOCs, and PCBs. In addition, five samples were analyzed for VOCs. Four samples were analyzed for TOC, TSS, TDS, and total and dissolved metals, and one sample was analyzed for pesticides.

4.1.2.2 Analytical Results. The data summary table (Table 4-1) presents analytical results for all samples collected at the site. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow direct comparison of naturally occurring organic compounds and inorganic analytes with samples collected from the site. Sample

locations and analytical results for the samples at the site are illustrated in Figures 4-1 and 4-2. Table 4-2 presents the immunoassay field screening results for PCBs. All organic compounds detected are presented on the figures except when they were a result of laboratory contamination or field decontamination procedures. Only metals detected above background levels that exceed an RBSL or ARAR are presented on Figures 4-1 and 4-2. The exceptions are presented on the data summary table.

The following section presents a discussion of organic compounds and inorganic analytes detected above background levels at the site. A discussion of TDS, TSS, and TOC is included.

Organics. Organic compounds detected in soil and sediment samples collected at the site included DRPH, GRPH, RRPH, BTEX, VOCs, SVOCs, and PCBs. DRPH were detected in six samples at concentrations ranging from 441 to 18,600 mg/kg. GRPH were detected in six samples ranging from 0.665 to 50.9 mg/kg. RRPH were detected in six samples ranging from 20,000 to 43,000 mg/kg. BTEX compounds were detected at low levels in nine samples. Total BTEX concentrations ranged from 0.24 to 15.1 mg/kg; xylenes were the primary component. A total of thirteen other VOCs were detected in eleven soil/sediment samples at concentrations ranging from 0.043 to 17.3 mg/kg. The primary VOCs detected were carbon tetrachloride (17.3 mg/kg) and trichloroethene (15.3 mg/kg). Four SVOCs were detected at low levels in soil samples LF01-4S40-5 and LF01-4S44-4 ranging from 0.23 to 8.6 mg/kg. Two groups of PCBs, Aroclor 1254 and Aroclor 1260, were detected at the site. Aroclor 1254 was detected in one sediment sample collected at the ocean/shore interface (sample LF01-3SD23) at 0.235 mg/kg. Later samples were collected along the ocean/shore interface, and no PCBs were detected in these samples. Aroclor 1260 was detected in 16 soil samples at concentrations ranging from 0.018 to 999 mg/kg. In addition, PCBs were detected at ≥10 mg/kg in ten other soil samples using immunoassay field screening. All significant levels of PCBs were detected in samples from gravel covered area #1.

In surface water samples, organic compounds detected include BTEX and six other VOCs. BTEX were detected in four samples at concentrations ranging from 1 to 9.6 μg/L. Six other VOCs were detected ranging from 1 to 89 μg/L. The primary VOCs detected were carbon tetrachloride (89 μg/L) and trichloroethene (62 μg/L).

Inorganics. In soil and sediment, metals analyses indicated that only one metal, sodium, was detected above background levels at the site. Sodium was detected in four samples at concentrations ranging from 130 to 290 mg/kg.

In surface water samples, six metals (aluminum, barium, iron, magnesium, manganese, and sodium) were detected above background levels. In surface water samples, TOC ranged from 10,200 to 52,900 μg/L. TSS were reported between 2,500 and 56,000 μg/L, and TDS were reported ranging from 236,000 to 688,000 μg/L.

4.1.2.3 Summary of Site Contamination. Previous sampling conducted at the Landfill and Waste Accumulation Area (LF01) detected BTEX and other VOCs, SVOCs, metals, and PCBs in soil (Woodward-Clyde 1992). The results and the sources of previous sampling efforts are presented in the RI/FS Work Plan (U.S. Air Force 1993a). The quality of the previous IRP

sampling data is unknown as is the data validation that these data have undergone. Previous sampling data are presented on Figures 4-1 and 4-2.

During previous soil sampling conducted in 1992, BTEX were detected in three samples; total BTEX ranged from 0.006 to 10 mg/kg. Twenty-two other VOCs and SVOCs were detected in soil samples at low levels ranging from 0.0006 to 4 mg/kg. PCBs (Aroclor 1260) were detected in soil samples ranging from 0.059 to 15.6 mg/kg. Nine metals were previously detected above background concentrations.

During the current RI investigation, BTEX were detected in soil samples at similar concentrations (0.24 to 15.1 mg/kg) to previous sampling, and 17 other VOCs and SVOCs were detected in soil at higher concentrations (0.043 to 17.3 mg/kg). BTEX and six other VOCs also were detected in surface water samples during the current RI investigation. PCBs were detected in soil/sediment samples at higher concentrations. The only inorganic compound detected above the background concentration in soil/sediment samples collected during the 1993 RI was sodium.

A comparison of historical and current project data indicates that the concentrations of BTEX, VOCs, and SVOCs in soil/sediment at the Landfill and Waste Accumulation Area site are similar to those detected in the past. However, higher concentrations of PCBs in soil and sediment were detected during the 1993 RI. Differences between past and current data are likely to be a result of more extensive sampling during the 1993 RI. The human health and ecological risks associated with the chemicals detected at the site are presented in Sections 4.1.4 and 4.1.5.

The suspected source of contaminants detected during sampling conducted at the Landfill and Waste Accumulation Area site is buried drums of waste liquids, garbage, and debris from previous waste disposal practices. The landfill has been inactive since 1977. The human health and ecological risks associated with the chemicals detected at the site are presented in Sections 4.2.4 and 4.2.5.

Based on field data, source of contamination, and concentration of the contaminants, significantly contaminated soil and sediment appear to be limited to the gravel areas #1 and #2 on the west end of the site and the excavated material inside the containment cell (materials excavated from the sludge pile/buried drum area). These areas cover approximately 12,100 square feet of landfill material or an estimated volume of 2,427 cubic yards.

4.1.3 Migration Pathways

This section describes the topography and stratigraphy of the site and the migration potential of contaminants from the site. A discussion of receptors and chemical concentrations at receptors is included.

4.1.3.1 Topography and Stratigraphy. The Landfill and Waste Accumulation Area consists of three contiguous areas east of the main station. The three areas are not clearly defined. The site is bordered by beaches on the northern side and a small lake on the east side. The eastern portion of the site is covered by a well graded gravel cap while the western portion consists mainly of tundra. A beach bluff along the northern edge of the site begins near the east

end of the site where the gravel cap meets the tundra and rises to a height of approximately 15 feet.

The small lake located along the eastern edge of the site is drained via a small outlet stream to the beach, where it infiltrates just prior to reaching the Chukchi Sea. Small ponds and drainage features are present in the tundra area of the site. Several small intermittent streams were also observed along the northern edge of the site.

The active layer at this site was approximately two feet thick throughout the tundra covered area of this site during the 1993 RI. Gravel pad materials at this site were of the typical gravels and sands associated with these features, and subsurface materials investigated at the site were of the typical stratigraphy associated with Cape Lisburne (Section 2.4.4.2). Along the beach, subsurface materials consisted of the typical sands, gravels, and fine materials associated with these features.

4.1.3.2 Migration Potential.

Subsurface Migration. Topography at the site indicates that any subsurface drainage should flow north towards the Chukchi Sea. There are no retentive features to prevent the active layer water from moving northward. Analytical data indicate that contaminants were migrating from the sludge pile/buried drum area and gravel covered areas #1 and #2 towards the Chukchi Sea. This indicates that there is a potential for subsurface migration from the landfill. Based on the local topography, subsurface water which has been affected by organic compounds should flow north and may emerge in the drainage pathways located along the beach bluff or be discharged directly to the Chukchi Sea.

Surface Migration. The site topography indicates that surface water should drain generally to the north, primarily through small intermittent streams that drain ponded areas. In the tundra areas, the intermittent streams join to form more distinct drainage pathways where they meet the bluff. Analytical data indicate that surface migration of contaminants has occurred in the tundra covered portion of the site downgradient of gravel covered areas #1 and #2 and the sludge pile/buried drum area. As part of IRA activities conducted in May 1995, the sludge pile/buried drum area was excavated and placed in a lined containment cell to prevent further migration of contaminants from this area of the site. Analytical data indicate that surface migration is not a concern from the east gravel capped portion of the Landfill and Waste Accumulation Area.

Air Transport. Air transportation is not considered to be a significant mode of migration at the site (Section 2.4.4.5).

Summary of Migration Potential. Analytical data suggest that three localized areas of soil in the west portion of the Landfill and Waste Accumulation area are contaminated with petroleum hydrocarbons, PCBs, and VOCs. Surface water and sediment samples suggest that contaminant migration from this area is occurring in surface or subsurface water. These three areas are the sludge pile/buried drum area, which was excavated and placed in a containment cell, and gravel covered areas #1 and #2. Based upon the analytical data, there has been contaminant migration from these areas and additional contaminant migration is possible.

4.1.3.3 Receptors and Chemical Concentrations at Receptors.

Human Receptors. Potential human receptors at the Landfill and Waste Accumulation Area site include Air Force contractor personnel working at the station, visitors to the station, and an occasional local visitor passing the site to get to recreational or subsistence lands. Human receptors could potentially be exposed to the chemicals detected in surface water and soil/sediments at the site. The primary routes of potential exposures at the site are direct contact with soil/sediment, incidental ingestion of soil/sediment, and ingestion of surface water. Because groundwater and air at the Cape Lisburne sites are not considered complete pathways of exposure, these media are not evaluated as potential pathways to human receptors.

The Cape Lisburne Risk Assessment (U.S. Air Force 1996) evaluates in detail the risks to human health from all COCs detected at the site. The potential receptor groups were selected based on their likelihood of exposure to contaminants at the site and include radar installation workers, and native adults and children who may visit the site. The estimated exposure point concentrations for human receptors are based on the maximum concentration of each chemical detected at the site. The potential risks to human health associated with chemicals detected at the site are presented in Section 4.1.4.

Ecological Receptors. Ecological receptors were evaluated in detail in the Cape Lisburne Risk Assessment (U.S. Air Force 1996) to determine if plants and animals could potentially be impacted by the chemicals detected at the Cape Lisburne installation. Because of the diversity of the plants and animals in the area of the Cape Lisburne installation, a set of representative species was selected in the ERA for detailed evaluation. The species include plants, aquatic invertebrates, fish, birds, and mammals. These receptors were selected based primarily on their likelihood of exposure given their preferred habitat and feeding habits. The representative species encompass a range of ecological niches in order to achieve the best characterization of the ecosystems being examined and are presented in Table 2-6.

The estimate of chemical concentrations at the ecological receptors was based on the average site-wide concentration of each COC. This approach was appropriate because few of the representative species would inhabit only one distinct site at the installation; they are more likely to be exposed to the mix of chemicals and concentrations detected on all the sites at Cape Lisburne. The potential ecological risks associated with the chemicals at detected at the site are presented in Section 4.1.5.

4.1.4 Human Health Risk Assessment

This section presents a summary of the potential human health risks associated with the chemicals detected at the Landfill and Waste Accumulation Area (LF01) site. The purpose of the human health risk assessment is to quantify the excess lifetime cancer risk and/or the noncancer hazard (reported as hazard index) from the chemicals detected at the site. Because the sludge pile/buried drum area was excavated and placed into a containment cell, sample results from contained soils were not used in the risk assessment.

This summary presents the COCs at the site, the pathways by which human receptors may be exposed to site chemicals, potential risks to human health posed by each chemical through each exposure pathway, the significance of the risk and/or hazard estimate, and a comparison of site chemical concentrations to ARARs. The methods and assumptions used in calculating hazards and risks are presented in Section 2.4.1.

4.1.4.1 Chemicals of Concern. At the Landfill and Waste Accumulation Area (LF01), COCs identified in soil/sediment matrix are DRPH, RRPH, carbon tetrachloride, trichloroethene, and PCBs (Aroclor 1260). DRPH and RRPH were selected because concentrations detected exceeded an ARAR, and carbon tetrachloride and trichloroethene were selected because concentrations exceeded the RBSLs based on cancer risk. Concentrations of PCBs (Aroclor 1260) exceeded both the ARAR and RBSL limits. Benzene, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, barium, and manganese were determined to be COCs in surface water at the site because the maximum concentration detected exceeded the associated background concentrations and RBSLs. Benzene, carbon tetrachloride, and trichloroethene in surface water also exceed the ARARs.

Table 4-3, Identification of COCs at the Landfill and Waste Accumulation Area, presents the maximum concentrations of chemicals detected at the site and associated background concentrations, RBSLs, and ARARs, and identifies COCs selected in the risk evaluation.

4.1.4.2 Exposure Pathways and Potential Receptors. Because COCs were identified for soil/sediment and surface water at the site, the potential risks associated with ingestion of soil/sediment and ingestion of surface water were evaluated in the risk assessment.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to the Cape Lisburne installation (worker), an adult inhabitant of the North Slope of Alaska (native), and a child living in a North Slope community (child).

4.1.4.3 Risk Characterization.

Noncancer Hazard and Cancer Risk Associated with Soils and Sediments. The noncancer hazard associated with the ingestion of soil/sediment at the Landfill and Waste Accumulation Area (LF01) site by a hypothetical native northern adult/child is 62, and by a radar installation worker is 3, based on the maximum concentrations of the COCs. The presence of Aroclor 1260 accounts for more than 99 percent of the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of soil at the site by a hypothetical native northern adult/child is 1×10^{-3}, and by a radar installation worker is 6×10^{-5}, based on the maximum concentrations of the COCs. The presence of Aroclor 1260 accounts for 99 percent of the quantifiable excess lifetime cancer risk for these receptor/pathway combinations. (Note: excess lifetime cancer risks, noncancer hazards, and the significance of reported values are discussed in Section 2.4.1.)

Noncancer Hazard and Cancer Risk Associated with Surface Water. The noncancer hazard associated with the ingestion of surface water at the Landfill and Waste Accumulation Area (LF01) site by hypothetical native northern adults or radar installation workers is 7, based on the

maximum concentrations of the COCs. The presence of manganese accounts for 99 percent of the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of surface water at the site by native northern adults is 1×10^{-4}, and by radar installation workers is 2×10^{-5}, based on the maximum concentrations of the COCs. The presence of benzene, tetrachloroethene, carbon tetrachloride, trichloroethene, and chloroform accounts for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

4.1.4.4 Summary of Human Health Risk Assessment. The potential risks and hazards associated with the soil/sediment at the Landfill and Waste Accumulation Area (LF01) are the noncancer hazards associated with Aroclor 1260 (hazard indices of 3 and 62), and the cancer risk associated with Aroclor 1260. Although these noncancer hazards are above one and cancer risks are greater than 1×10^{-4}, the hazards and risks were calculated conservatively based on a residential scenario. However, the noncancer hazards and cancer risks associated with soil/sediment at the site are potentially significant, and remediation is recommended.

A hazard index of 7 is associated with manganese in surface water at the site. The cancer risk for the native adult is 1×10^{-4} and for radar installation workers is 2×10^{-5}, neither exceed the 1×10^{-4} threshold level at which remediation is usually recommended (EPA 1991b). This potential risk was calculated assuming the affected surface water would be used as a sole-source water supply for 180 days per year. Based on site-specific information, the chemicals in surface water do not currently pose a health hazard nor are they likely to pose a hazard in the future. The surface water expressions at the site are frozen most of the year; many are only intermittently filled with water during the summer months. The surface water at the site is not known to be used as a water supply now, nor has it been used in the past. In conclusion, under current uses the COCs identified in surface water at the Landfill and Waste Accumulation Area site pose only a minimal, if any, potential threat to human health. In the unlikely event that surface water at the site is used as a sole-source drinking water supply in the future, a potential noncancer hazard to human health could exist if conditions remain constant.

In conclusion, under current uses the COCs identified surface water at the Landfill and Waste Accumulation Area pose only minimal, if any, potential threat to human health. However, the COCs identified in the soil/sediment at the site could potentially pose a threat to human health under the residential scenario assumed in the Risk Assessment (U.S. Air Force 1996). Based on the human health risk assessment, remedial actions are recommended at the site.

4.1.5 Ecological Risk Assessment

The objective of the ERA was to estimate the potential impacts of chemicals detected at the installation to aquatic and terrestrial plants and animals. A summary of the methods used to assess potential ecological impacts is presented in Section 2.4.2.

4.1.5.1 Chemicals of Concern. COCs were selected based on criteria presented in Section 3.1 of the ERA. The average installation-wide concentrations of COCs were used to calculate the risk estimates. All sites at the installation were considered to be potentially usable habitat. It should be noted that the COC selection process only considered the soil/sediment

samples that were 1.5 feet deep or less. The soil/sediment samples were screened for depth because it is unlikely that any of the representative species will be exposed to soils/sediments deeper than 1.5 feet. Iron and manganese were identified as COCs in surface water, and the COCs in soils/sediments at the Landfill and Waste Accumulation Area were DRPH, GRPH, RRPH, benzene, toluene, xylenes, 1,2,4-trimethylbenzene, Aroclor 1254, and Aroclor 1260. Iron and manganese in surface water were associated with elevated HQs, and Aroclor 1254 and Aroclor 1260 were the soil/sediment COCs associated with elevated risk estimates at the site.

4.1.5.2 Exposure Pathways and Potential Receptors. Potential exposure pathways for terrestrial and aquatic organisms include direct contact with, and ingestion of, contaminated soil/sediment and/or surface water. The most significant route of exposure for plants is direct contact with soil. Aquatic organisms such as fish and invertebrates are primarily exposed through direct contact with surface water, and average surface water concentrations were used to evaluate potential exposures. They may also be exposed to COCs through ingestion of plant and animal items in their diet, and incidental ingestion of soil/sediment while foraging, although these pathways are considered less significant and are not used to calculate HQs. Birds and mammals may be exposed to COCs through ingestion of surface water, ingestion of plant and animal diet items (although only ingestion of plant matter was quantified in the estimated exposure equation), and incidental ingestion of soil/sediment.

The potential ecological receptors evaluated in the risk assessment include plants, aquatic organisms, and birds, and mammals likely to occur along the Arctic Coastal Plain. Representative species from these receptor groups were selected based primarily on the species' likelihood of exposure, preferred habitat, and feeding habits. Species that may be particularly sensitive to environmental impacts, such as threatened and endangered species, are considered on an individual basis if present at or near the installation. No sensitive species were identified (Alaska Biological Research 1994) or evaluated at the Cape Lisburne installation. The species evaluated in the ERA are listed in Table 2-6.

4.1.5.3 Risk Characterization. Potential risks to *Daphnia* spp. at the Landfill and Waste Accumulation Area were attributed to iron and manganese in surface water. The HQs were 2.4 and 1.6 for iron and manganese, respectively. In soil/sediment, the HQs, based on levels of Aroclor 1254 were above 1.0 for the brant (1.8), pectoral sandpiper (7), and brown lemming (7). Based on levels of Aroclor 1260, HQs were above 1.0 for the glaucous gull (2.4), Lapland longspur (7), brant (17), pectoral sandpiper (69), and brown lemming (69). HQs for all remaining COCs were below 1.0 for all of the other representative species.

4.1.5.4 Summary of Ecological Risk Assessment. Although the HQs are elevated for iron and manganese in surface water, the essential nutrient status, uncertainty associated with the toxicity reference values for these metals, and relatively low HQs indicate that the risk from these two metals in surface water is likely to be inconsequential. Currently, there may be low risk to terrestrial species associated with the PCBs, Aroclor 1254 and Aroclor 1260; however, future risk may be greater because of the high potential for bioaccumulation of PCBs in the food chain.

4.1.6 Conclusions and Recommendations

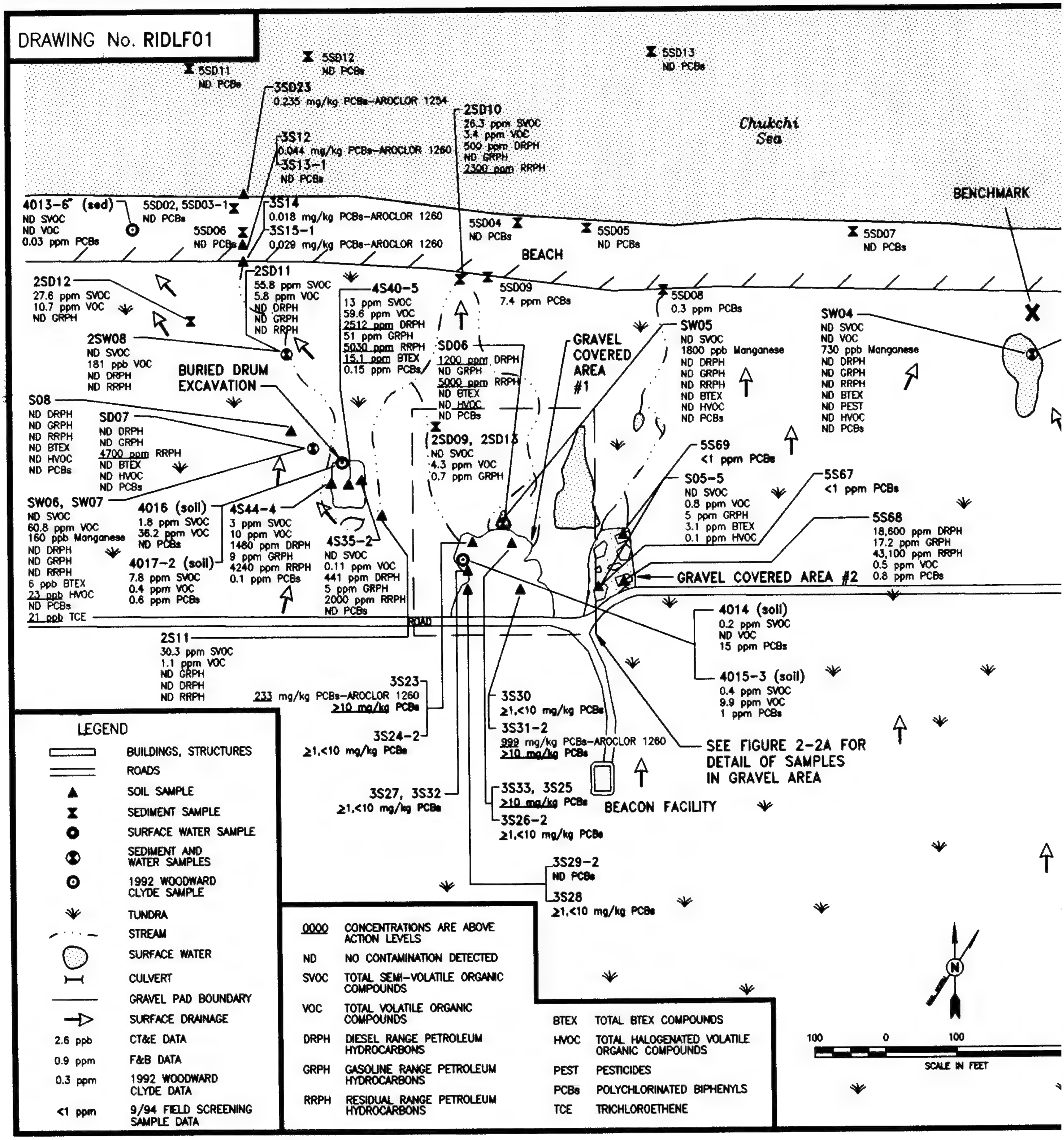
Sampling and analyses have determined that the Landfill and Waste Accumulation Area (LF01) site is contaminated with petroleum hydrocarbons, PCBs, and VOCs. The affected areas at the site are primarily soil/sediment and surface water within the western portion of the site. In addition, the affected areas are primarily associated with the gravel covered areas (#1 and #2) and the sludge pile/buried drum area, which was excavated and placed in the containment cell.

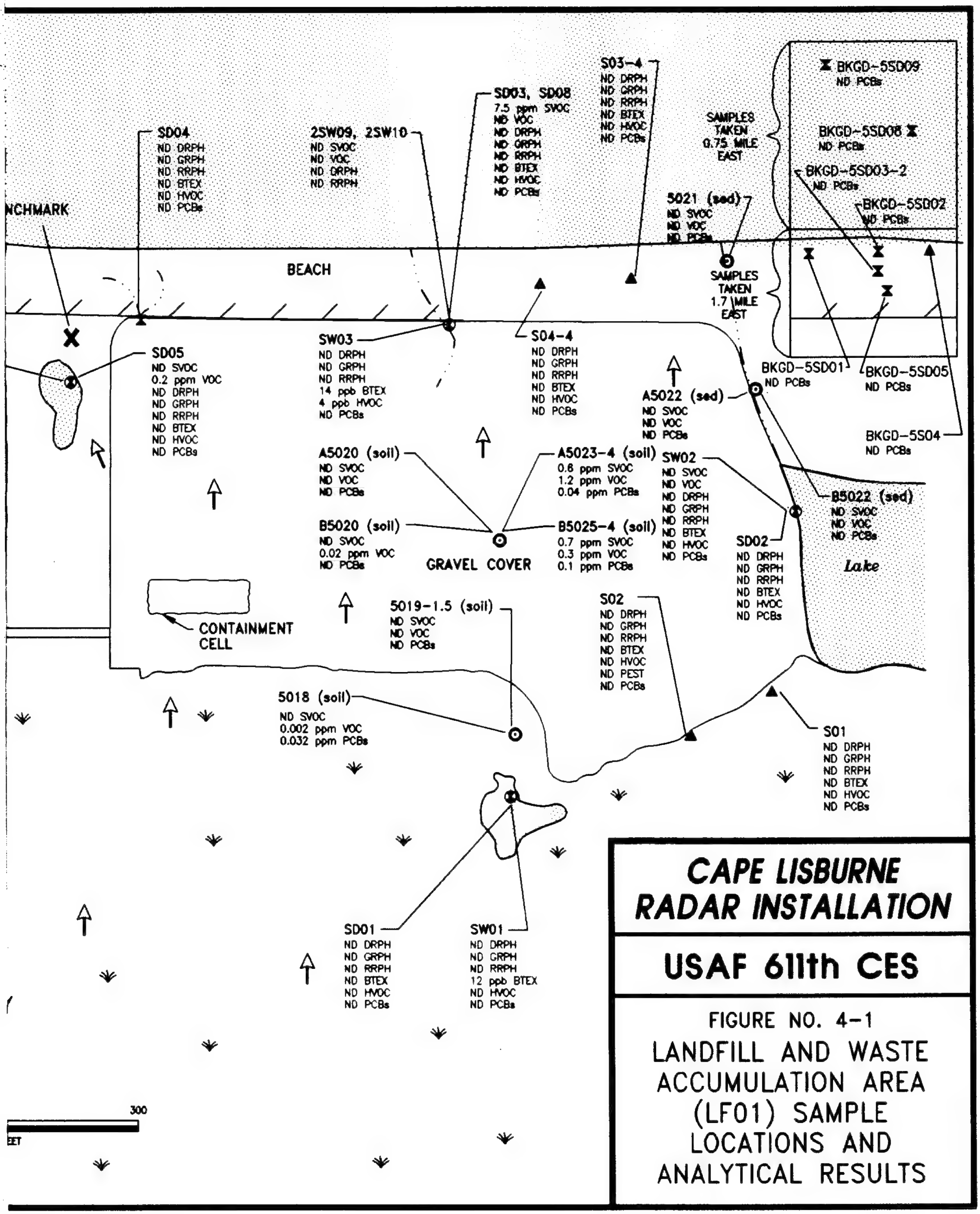
Migration of contaminants from the site appears to have occurred to a limited degree through drainage pathways that lead from these areas north to the Chukchi Sea. Relatively low levels of petroleum hydrocarbons, VOCs, and SVOCs were detected in soil/sediment and surface water samples collected from the drainage pathways leading from these areas.

An IRA was conducted during 1994 and 1995 at the Landfill and Waste Accumulation Area site to remove the sludge pile/buried drum area that appeared to be the primary source area that was causing contamination to move downgradient to the natural tundra drainage and towards the Chukchi Sea. Excavated soils were placed in a lined containment cell located on the east gravel capped end of the landfill.

The risk assessment concluded that there is a potential risk posed to human health and ecological receptors by site contaminants, given current site uses and under a future scenario. This risk is of a magnitude that normally requires remedial action (EPA 1991b). In addition, levels of petroleum compounds (primarily residual oils) and PCBs detected at the site significantly exceed ADEC cleanup levels, and migration of contaminants has occurred. Therefore, under current site conditions and considering the findings of the risk assessment, remediation of the site is recommended.

Offsite treatment/disposal is recommended as the alternative for remediation of the affected areas at the site (gravel covered areas #1 and #2 and soils in the containment cell). A complete description and evaluation of the remedial alternatives considered for this site and the rational for the selected alternatives are presented in the Feasibility Study, Section 5.0.


DRAWING No. RIDLF01
5SD11
ND PCBs
5SD12
ND PCBs
5SD13
ND PCBs
3SD23
0.235 mg/kg PCBs-AROCLOR 1254
2SD10
26.3 ppm SVOC
3.4 ppm VOC
500 ppm DRPH
ND GRPH
2300 ppm RRPH
3S12
0.044 mg/kg PCBs-AROCLOR 1260
3S13-1
ND PCBs
Chukchi Sea
BENCHMARK
4013-6" (sed)
ND SVOC
ND VOC
0.03 ppm PCBs
5SD02, 5SD03-1
ND PCBs
5SD06
ND PCBs
3S14
0.018 mg/kg PCBs-AROCLOR 1260
3S15-1
0.029 mg/kg PCBs-AROCLOR 1260
5SD04
ND PCBs
5SD05
ND PCBs
5SD07
ND PCBs
BEACH
2SD12
27.6 ppm SVOC
10.7 ppm VOC
ND GRPH
2SD11
55.8 ppm SVOC
5.8 ppm VOC
ND DRPH
ND GRPH
ND RRPH
4S40-5
13 ppm SVOC
59.6 ppm VOC
2512 ppm DRPH
51 ppm GRPH
5030 ppm RRPH
15.1 ppm BTEX
0.15 ppm PCBs
5SD09
7.4 ppm PCBs
5SD08
0.3 ppm PCBs
SW04
ND SVOC
ND VOC
730 ppb Manganese
ND DRPH
ND GRPH
ND RRPH
ND BTEX
ND PEST
ND HVOC
ND PCBs
2SW08
ND SVOC
181 ppb VOC
ND DRPH
ND RRPH
BURIED DRUM EXCAVATION
SD06
1200 ppm DRPH
ND GRPH
5000 ppm RRPH
ND BTEX
ND HVOC
ND PCBs
GRAVEL COVERED AREA #1
SW05
ND SVOC
1800 ppb Manganese
ND DRPH
ND GRPH
ND RRPH
ND BTEX
ND HVOC
ND PCBs
S08
ND DRPH
ND GRPH
ND RRPH
ND BTEX
ND HVOC
ND PCBs
SD07
ND DRPH
ND GRPH
4700 ppm RRPH
ND BTEX
ND HVOC
ND PCBs
2SD09, 2SD13
ND SVOC
4.3 ppm VOC
0.7 ppm GRPH
5S69
<1 ppm PCBs
S05-5
ND SVOC
0.8 ppm VOC
5 ppm GRPH
3.1 ppm BTEX
0.1 ppm HVOC
5S67
<1 ppm PCBs
SW06, SW07
ND SVOC
60.8 ppm VOC
160 ppb Manganese
ND DRPH
ND GRPH
ND RRPH
6 ppb BTEX
23 ppb HVOC
ND PCBs
21 ppb TCE
4016 (soil)
1.8 ppm SVOC
36.2 ppm VOC
ND PCBs
4S44-4
3 ppm SVOC
10 ppm VOC
1480 ppm DRPH
9 ppm GRPH
4240 ppm RRPH
0.1 ppm PCBs
4017-2 (soil)
7.8 ppm SVOC
0.4 ppm VOC
0.6 ppm PCBs
4S35-2
ND SVOC
0.11 ppm VOC
441 ppm DRPH
5 ppm GRPH
2000 ppm RRPH
ND PCBs
5S68
18,600 ppm DRPH
17.2 ppm GRPH
43,100 ppm RRPH
0.5 ppm VOC
0.8 ppm PCBs
GRAVEL COVERED AREA #2
ROAD
4014 (soil)
0.2 ppm SVOC
ND VOC
15 ppm PCBs
4015-3 (soil)
0.4 ppm SVOC
9.9 ppm VOC
1 ppm PCBs
2S11
30.3 ppm SVOC
1.1 ppm VOC
ND GRPH
ND DRPH
ND RRPH
3S23
233 mg/kg PCBs-AROCLOR 1260
≥10 mg/kg PCBs
3S24-2
≥1,<10 mg/kg PCBs
3S30
≥1,<10 mg/kg PCBs
3S31-2
999 mg/kg PCBs-AROCLOR 1260
≥10 mg/kg PCBs
SEE FIGURE 2-2A FOR DETAIL OF SAMPLES IN GRAVEL AREA
3S27, 3S32
≥1,<10 mg/kg PCBs
3S33, 3S25
≥10 mg/kg PCBs
BEACON FACILITY
3S26-2
≥1,<10 mg/kg PCBs
3S29-2
ND PCBs
3S28
≥1,<10 mg/kg PCBs
LEGEND
BUILDINGS, STRUCTURES
ROADS
SOIL SAMPLE
SEDIMENT SAMPLE
SURFACE WATER SAMPLE
SEDIMENT AND WATER SAMPLES
1992 WOODWARD CLYDE SAMPLE
TUNDRA
STREAM
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppb CT&E DATA
0.9 ppm F&B DATA
0.3 ppm 1992 WOODWARD CLYDE DATA
<1 ppm 9/94 FIELD SCREENING SAMPLE DATA
0000 CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND NO CONTAMINATION DETECTED
SVOC TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
VOC TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH GASOLINE RANGE PETROLEUM HYDROCARBONS
RRPH RESIDUAL RANGE PETROLEUM HYDROCARBONS
BTEX TOTAL BTEX COMPOUNDS
HVOC TOTAL HALOGENATED VOLATILE ORGANIC COMPOUNDS
PEST PESTICIDES
PCBs POLYCHLORINATED BIPHENYLS
TCE TRICHLOROETHENE
N
100 0 100
SCALE IN FEET

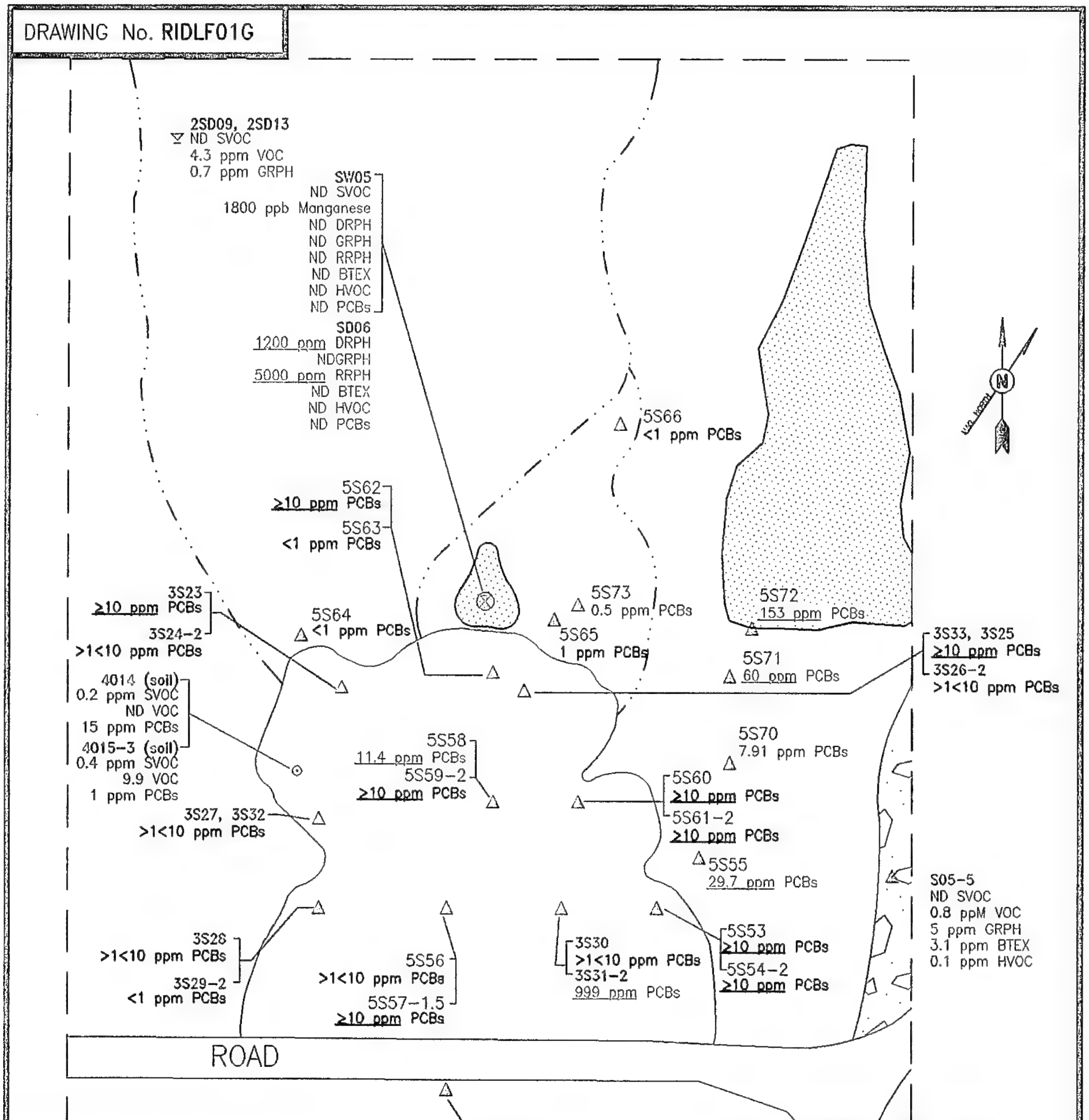


CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 4-1
LANDFILL AND WASTE ACCUMULATION AREA (LF01) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

DRAWING No. RIDLF01G



LEGEND

ROADS
△ SOIL SAMPLE
SEDIMENT SAMPLE
SEDIMENT AND WATER SAMPLES
WOODWARD CLYDE SAMPLE
STREAM
SURFACE WATER
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppb CT&E DATA
<1 ppm 9/94 FIELD SCREENING SAMPLE DATA

20 0 20 80
SCALE IN FEET

0000 CONCENTRATIONS ARE ABOVE ACTION LEVELS
PCBs POLYCHLORINATED BIPHENYLS

CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 4-2
GRAVEL COVERED AREA #1 AT THE LANDFILL AND WASTE ACCUMULATION AREA SAMPLE LOCATIONS AND ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S01	S02	S03-4	S04-4	S05-5	AB01	EB02	TB02		
Laboratory Sample ID Numbers					1594	1596	1598	1600	1602 4514-11	4512-3	1510/1542 4512-1	1514 4512-2	#6-9393 #1&2-9493 4512	#3&4-9493 #6-9593 4514
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-8	50-80	500[a]	<60[b]-<150[b]	<60[b]	<60[b]	<50[b]	<70[b]	NA	NA	<1,000J[b]	NA	<2,000	<50
GRPH	0.2-0.3	2-3	100	<2J[b]-<6J[b]	<3J[b]	<3J[b]	<2J[b]	<3J[b]	5J[b]	NA	<50J[b]	<50J[b]	<50	<2J-<20
RRPH (Approx.)	10-20	100-200	2,000[a]	<120-<300	<200	<200	<100	<200	NA	NA	<2,000	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	<0.15	<0.15	<0.1	<0.1	3.1J					
Benzene	0.002-0.003	0.02-0.03	0.5	<0.02-<0.06	<0.03	<0.03	<0.02	<0.02	<0.02	NA	<1	<1	<1	<0.02-<0.2
Toluene	0.002-0.003	0.02-0.03		<0.02-<0.06	<0.03	<0.03	<0.02	<0.02	<0.02	NA	<1	<1	<1	<0.02-<0.2
Ethylbenzene	0.002-0.003	0.02-0.03		<0.02-<0.06	<0.03	<0.03	<0.02	<0.02	0.6	NA	<1	<1	<1	<0.02-<0.2
Xylenes (Total)	0.004-0.006	0.04-0.06		<0.04-<0.12	<0.06	<0.06	<0.04	<0.04	2.5J	NA	<2	<2	<2	<0.04-<0.4
HVOC 8010														
Trichloroethene	0.002-0.003	0.02-0.03		<0.02J-<0.06J	<0.03J	<0.03J	<0.02J	<0.02J	0.1J	NA	<1J	<1J	<1	<0.02J
VOC 8260														
cis-1,2-Dichloroethene	0.020	0.025		<0.025-<0.160	NA	NA	NA	NA	0.048	<1	<1	<1	<1	<0.020
p-Isopropyltoluene	0.020	0.025		<0.025-<0.160	NA	NA	NA	NA	0.113	<1	<1	<1	<1	<0.020
Trichloroethene	0.020	0.025		<0.025-<0.160	NA	NA	NA	NA	0.390	<1	<1	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.025		<0.025-<0.160	NA	NA	NA	NA	0.285	<1	<1	<1	<1	<0.020
SVOC 8270	0.200	7.98		1.61U-20.4JB	NA	NA	NA	NA	<7.98	NA	<11	NA	<10	0.878

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S01	S02	S03-4	S04-4	S05-5	AB01	EB02	TB02		
Laboratory Sample ID Numbers					1594	1596	1598	1600	1602 4514-11	4512-3	1510/1542 4512-1	1514 4512-2	#6-9393 #1&2-9493 4512	#3&4-9493 #6-9593 4514
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
Pesticides	0.001-0.05	0.01-0.5		<0.01J-0.07R	NA	<0.01J-<0.5J	NA	NA	NA	NA	<0.2J-<10	NA	NA	NA
PCBs	0.01-0.4	0.1-4.0	10	<0.02-20JN	<0.1	<0.1	<0.1	<0.1	NA	NA	<2J	NA	NA	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
R Result has been rejected.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples		Field Blanks					Lab Blanks	
					S08	2S11	AB01	2EB04	EB02	2TB04	TB02		
Laboratory Sample ID Numbers					1608	1923 4728-8	4512-3	1924 4727-10	1510/1542 4512-1	4727-9	1514 4512-2	#6-9393 #1&2-9493 4512	#3&4-9493 #6-9593 4514
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	14-15	140-150	500[a]	<60[b]-<150[b]	<150[b]	<140[b]	NA	<1,000[b]	<1,000J[b]	NA	NA	<2,000	<50
GRPH	0.400-0.8	0.400-8	100	<2J[b]-<6J[b]	<8J[b]	<1.80	NA	<20	<50J[b]	NA	<50J[b]	<50	<2J-<20
RRPH (Approx.)	30-40	300-400	2,000[a]	<120-<300	<400	<300	NA	<4,000	<2,000	NA	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	<0.30								
Benzene	0.006	0.06	0.5	<0.02-<0.06	<0.06	NA	NA	NA	<1[c]	NA	<1	<1	<0.02-<0.2
Toluene	0.006	0.06		<0.02-<0.06	<0.06	NA	NA	NA	<1[c]	NA	<1	<1	<0.02-<0.2
Ethylbenzene	0.006	0.06		<0.02-<0.06	<0.06	NA	NA	NA	<1[c]	NA	<1	<1	<0.02-<0.2
Xylenes (Total)	0.012	0.12		<0.04-<0.12	<0.12	NA	NA	NA	<2[c]	NA	<2	<2	<0.04-<0.4
HVOC 8010	0.006	0.06		<0.02J-<0.06J	<0.06J	NA	NA	NA	<1J	NA	<1J	<1	<0.02J
VOC 8260													
Toluene	0.020	0.090		<0.025-<0.160	NA	0.300	<1	<1J	<1	<1J	<1	<1	<0.020
1,2,4-Trimethyl-benzene	0.020	0.090		<0.025-<0.160	NA	0.305	<1	<1J	<1	<1J	<1	<1	<0.020
Xylenes (Total)	0.040	0.180		<0.050-<0.320	NA	0.522	<2	<2J	<2	<2J	2	<2	<0.040

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The samples were collected prior to interim remedial action (clean up) field activities; site conditions have since changed.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples		Field Blanks					Lab Blanks	
					S08	2S11	AB01	2EB04	EB02	2TB04	TB02		
Laboratory Sample ID Numbers					1608	1923 4728-8	4512-3	1924 4727-10	1510/1542 4512-1	4727-9	1514 4512-2	#6-9393 #1&2-9493 4512	#3&4-9493 #6-9593 4514
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/kg
SVOC 8270													
di-n-Butylphthalate	0.200	11.8		1.61U-20.4JB	NA	30.3B	NA	NA	<11	NA	NA	<10	0.878
PCBs	0.4	0.1	10	<0.02-20JN	<4	NA	NA	<2	<2J	NA	NA	NA	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
U Compound is not present above the concentration listed.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					3S12	3S13-1	3S14	3S15-1	3S31-2	LF01 AB01	3EB02	LF01 3TB01		
Laboratory Sample ID Numbers					4608-7	4608-8	4608-9	4608-10	4742-1	4762-1	4742-2	4762-6	4742 4762	4608 4742 4762
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
PCBs														
Aroclor 1260	0.020	0.020	10	<0.02-20JN	0.044	<0.100	0.018J	0.029J	999	NA	<1	NA	<1	<0.03

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks	
					4S35-2	4S40-5	4S44-4	LF01 AB01	3EB02	4TB01		
Laboratory Sample ID Numbers					1850-2	1850-3	1850-4	4762-1	4742-2	1850-1	1850 4742 4762	1850
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	<60[b]-<150[b]	441	2,512	1,780	NA	NA	NA	NA	<4.00
GRPH	0.400	0.400	100	<2J[b]-<6J[b]	4.88	50.9	8.64	NA	NA	NA	NA	<1.00
RRPH (Approx.)	4.00	4.00	2,000[a]	<120-<300	2,000	5,030	4,240	NA	NA	NA	NA	<100
VOC 8260												
n-Butylbenzene	0.020	0.100		<0.025-<0.160	<0.100	0.636	<0.100	<1	NA	<1	<1	<0.050
sec-Butylbenzene	0.020	0.100		<0.025-<0.160	<0.100	0.168	<0.100	<1	NA	<1	<1	<0.050
Carbon Tetrachloride	0.020	0.100		<0.025-<0.160	0.110	17.3	<0.100	<1	NA	<1	<1	<0.050
Chloroform	0.020	0.100		<0.025-<0.160	<0.100	0.796	<0.100	<1	NA	<1	<1	<0.050
Ethylbenzene	0.020	0.100		<0.025-<0.160	<0.100	2.19	<0.100	<1	NA	<1	<1	<0.050
Isopropylbenzene	0.020	0.100		<0.025-<0.160	<0.100	0.242	<0.100	<1	NA	<1	<1	<0.050
p-Isopropyltoluene	0.020	0.100		<0.025-<0.160	<0.100	0.178	<0.100	<1	NA	<1	<1	<0.050
Naphthalene	0.020	0.100		<0.025-<0.160	<0.100	0.185	0.125	<1	NA	<1	<1	<0.050
n-Propylbenzene	0.020	0.100		<0.025-<0.160	<0.100	0.758	<0.100	<1	NA	<1	<1	<0.050
Toluene	0.020	0.100		<0.025-<0.160	<0.100	3.11	8.45	<1	NA	<1	<1	<0.050
Trichloroethene	0.020	0.100		<0.025-<0.160	<0.100	15.3	0.175	<1	NA	<1	<1	<0.050

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks	
					4S35-2	4S40-5	4S44-4	LF01 AB01	3EB02	4TB01		
Laboratory Sample ID Numbers					1850-2	1850-3	1850-4	4762-1	4742-2	1850-1	1850 4742 4762	1850
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
1,2,4-Trimethylbenzene	0.020	0.100		<0.025-<0.160	<0.100	6.89	0.486	<1	NA	<1	<1	<0.050
1,3,5-Trimethylbenzene	0.020	0.100		<0.025-<0.160	<0.100	2.04	<0.100	<1	NA	<1	<1	<0.050
Xylenes (Total)	0.040	0.200		<0.050-<0.320	<0.200	9.83	0.824	<2	NA	<2	<2	<0.100
SVOC 8270												
2-Methylnaphthalene	0.20	0.353-5.26		<0.250-<4.23	<0.353	8.59	0.229J	NA	NA	NA	NA	<0.100
4-Methylphenol	0.20	0.353-5.26		<0.250-<4.23	<0.353	<5.26	2.16	NA	NA	NA	NA	<0.100
Naphthalene	0.20	0.353-5.26		<0.250-<4.23	<0.353	4.26J	<0.354	NA	NA	NA	NA	<0.100
Phenol	0.20	0.353-5.26		<0.250-<4.23	<0.353	<5.26	0.920	NA	NA	NA	NA	<0.100
PCBs												
Aroclor 1260	0.020	0.08	10	<0.02-20JN	<0.08	0.149	0.100	NA	<1	NA	<1	<0.02

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					5S55	5S58	5S65	5S68	5S70	LF01 AB01	3EB02	5TB02		
Laboratory Sample ID Numbers					2610-1	2610-2	2610-3	2610-4	2610-5	4762-1	4742-2	2610-10	2610 4742 4762	2610
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	<60[b]-<150[b]	NA	NA	NA	18,600	NA	NA	NA	NA	NA	<4.00
GRPH	0.400	0.400	100	<2J[b]-<6J[b]	NA	NA	NA	17.2	NA	NA	NA	NA	NA	<1.00
RRPH (Approx.)	4.00	4.00	2,000[a]	<120-<300	NA	NA	NA	43,100	NA	NA	NA	NA	NA	<100
VOC 8260														
Methylene Chloride	0.020	0.050		<0.025-<0.160	NA	NA	NA	0.066	NA	<1	NA	<1	<1	<0.050
Naphthalene	0.020	0.050		<0.025-<0.160	NA	NA	NA	0.147	NA	<1	NA	<1	<1	<0.050
1,2,4-Trimethylbenzene	0.020	0.050		<0.025-<0.160	NA	NA	NA	0.166	NA	<1	NA	<1	<1	<0.050
1,3,5-Trimethylbenzene	0.020	0.050		<0.025-<0.160	NA	NA	NA	0.154	NA	<1	NA	<1	<1	<0.050
PCBs														
Aroclor 1260	0.020	0.020	10	<0.02-20JN	29.7	11.4	0.999	0.798	7.91	NA	<1	NA	<1	<0.020

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blank	Lab Blanks	
					5S71	5S72	5S73	3EB02		
Laboratory Sample ID Numbers					2610-6	2610-7	2610-8	4742-2	4742	2610
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
PCBs										
Aroclor 1260	0.020	0.020	10	<0.02-20JN	59.7	153	0.472	<1	<1	0.020

☐ CT&E Data.
▩ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples							Field Blanks			Lab Blanks	
					SD01	SD02	SD03 & SD08 (Replicates)		SD04	SD05	SD06	AB01	EB02	TB02		
Laboratory Sample ID Numbers					1578	1580	1582 4514-2	1592 4514-7	1584	1586 4514-8	1588	4512-3	1510/1542 4513-1 4512-1	1514 4512-2	#8-9393 #1&2-9493 4512	#8-9393 #3&4-9493 4512
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-56	50-560	500[a]	<80[b]-<150[b]	<140[b]	<80[b]	<100[b]	<80[b]	<560[b]	<360[b]	1,200[b]	NA	<1,000J[b]	NA	NA	<50
GRPH	0.2-4.0	2-40	100	<2J[b]-<8J[b]	<6J[b]	<2J[b]	<4J[b]	<3J[b]	<40J[b]	<130J[b]	<5J[b]	NA	<50J[b]	<50J[b]	<50	<2J-<20
RRPH (Approx.)	12-110	120-1,100	2,000[a]	<120-<300	<280	<120	<200	<200	<1,100	<710	5,000	NA	<2,000	NA	NA	<100
BTEX (8020/ 8020 Mod.)			10 Total BTEX	<0.1-<0.3	<0.3	<0.1	<0.2	<0.15	<1.0	<12.4	<0.25					
Benzene	0.002-0.02	0.02-0.2	0.5	<0.02-<0.06	<0.06	<0.02	<0.04	<0.03	<0.2	<0.2	<0.05	<1[c]	<1	<1	<1	<0.02-<0.2
Toluene	0.002-0.02	0.02-0.2		<0.02-<0.06	<0.06	<0.02	<0.04	<0.03	<0.2	<0.2	<0.05	<1[c]	<1	<1	<1	<0.02-<0.2
Ethylbenzene	0.002-0.5	0.02-5		<0.02-<0.06	<0.06	<0.02	<0.04	<0.03	<0.2	<5	<0.05	<1[c]	<1	<1	<1	<0.02-<0.2
Xylenes (Total)	0.004-0.7	0.04-7		<0.04-<0.12	<0.12	<0.04	<0.08	<0.06	<0.4	<7	<0.1	<2[c]	<2	<2	<2	<0.04-<0.4
HVOC 8010	0.002-0.02	0.02-0.2		<0.02J-<0.06J	<0.06J	<0.02J	<0.04J	<0.03J	<0.2J	<0.2J	<0.05J	NA	<1J	<1J	<5-<10	<0.02J
VOC 8260																
Toluene	0.020	0.040-0.160		<0.025-<0.160	NA	NA	<0.050	<0.040	NA	0.241	NA	<1	<1	<1	<1	<0.020
SVOC 8270																
di-n-Butyl-phthalate	0.200	6.23-29	8,000	1.61U-20.4JB	NA	NA	7.53B	<6.23	NA	<29.0	NA	NA	<11	NA	<10	0.878
PCBs	0.01	0.1	10	<0.02-20JN	<0.2	<0.1	<0.2	<0.1	<1.1	<0.7	<0.3	NA	<2J	NA	NA	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
U Compound is not present above the concentration listed.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Sample			Field Blanks				Lab Blanks	
					SD07	3SD23		AB01	EB02	3EB02	TB02		
Laboratory Sample ID Numbers					1590	4608-6		4512-3	1510/1542	4742-2	1514	#6-9393 #1&2-9493 4512	#6-9593 #3&4-9493
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	50	500	500[a]	<60[b]-<150[b]	<500[b]	NA		NA	<1,000J[b]	NA	NA	NA	<50
GRPH	2	20	100	<2J[b]-<6J[b]	<20J[b]	NA		NA	<50J[b]	NA	<50J[b]	<50	<1-<20
RRPH (Approx.)	50	500	2,000[a]	<120-<300	4,700	NA		NA	<2,000	NA	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	<1.0								
Benzene	0.02	0.2	0.5	<0.2-<0.6	<0.2	NA		<1[c]	<1	NA	<1	<1	<0.02-<0.2
Toluene	0.02	0.2		<0.2-<0.6	<0.2	NA		<1[c]	<1	NA	<1	<1	<0.02-<0.2
Ethylbenzene	0.02	0.2		<0.2-<0.6	<0.2	NA		<1[c]	<1	NA	<1	<1	<0.02-<0.2
Xylenes (Total)	0.04	0.4		<0.04-<0.12	<0.4	NA		<2[c]	<2	NA	<2	<2	<0.04-<0.4
HVOC 8010	0.02	0.2		<0.2J-<0.6J	<0.2J	NA		NA	<1J	NA	<1J	<1	<0.02
PCBs													
Aroclor 1254	0.020-0.1	0.020-1	10	<0.02-<0.3	<1J	0.235		NA	<2J	<1	NA	NA	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blank	Lab Blanks	
					2SD09 & 2SD13 (Replicates)		2SD10	2SD11	2SD12	AB01		
Laboratory Sample ID Numbers					4728-1	4728-7	1927 4728-4	1920 4728-5	4728-6	4512-3	#6-91393 4727 4512	#6-91393 4728
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	14-26	140-260	500[a]	<60[b]-<150[b]	NA	NA	500J[b]	<260[b]	NA	NA	<1,000	<50J
GRPH	0.400	0.400-6	10	<2J[b]-<6J[b]	0.665	<2.80	<2	<6	<5	NA	<50	<1-<20
RRPH (Approx.)	30-53	300-530	2,000[a]	<120-<300	NA	NA	2,300	<530	NA	NA	<4,000	<100
VOC 8260												
Benzene	0.020	0.035-0.300	0.5	<0.025-<0.160	<0.035J	0.144J	0.104	<0.300	0.256	<1	<1	<0.020
Ethylbenzene	0.020	0.035-0.300		<0.025-<0.160	0.060J	0.285J	0.225	0.400	0.690	<1	<1	<0.020
n-Propylbenzene	0.020	0.035-0.300		<0.025-<0.160	<0.035J	<0.150J	<0.100	<0.300	0.315	<1	<1	<0.020
Toluene	0.020	0.035-0.300		<0.025-<0.160	0.179J	1.13J	0.877	1.50	2.52	<1	<1	<0.020
1,2,4-Trimethylbenzene	0.020	0.035-0.300		<0.025-<0.160	0.133J	0.646J	0.533	0.949	1.73	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.035-0.300		<0.025-<0.160	0.043J	0.229J	0.189	0.321	0.600	<1	<1	<0.020
Xylenes (Total)	0.040	0.070-0.600		<0.05-<0.320	0.393J	1.876J	1.484	2.651	4.59	<2	<1	<0.040
SVOC 8270												
di-n-Butylphthalate	0.200	3.03-20.9	8,000	1.61U-20.4JB	7.02U	NA	26.3B	55.8B	27.6B	NA	NA	2.310

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
U Compound is not present above the concentration listed.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil/Sediment
Units: mg/kg
METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: SD03 & SD08 (Replicates)		Environmental Samples: SD05	Environmental Samples: S05	Environmental Samples: S06 & S09 (Replicates)		Field Blank: EB02	Lab Blanks
Laboratory Sample ID Numbers					4514-2	4514-7	4514-6	4514-11	4514-12	4514-13	4511-1	4514 4511
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L
Aluminum	0.35	2		4,700-17,000	4,900J	2,800J	5,200	6,000	6,600	8,200	<100	<100
Antimony	N/A	2-75		<61-<110	<47R	<75R	<88	<59R	<68	<61	<100	<100
Arsenic	0.11	8.8-75		<6.3-<69	<47	<75	<8.8	<59	<68	<61	<100	<100
Barium	0.024	1		590-2,000	630	540	430	230	500	400	<50	<50
Beryllium	N/A	1		<3.2-<31	<2.4	<3.8	<4.4	<3.0	<3.4	<3.1	<50	<50
Cadmium	0.33	1		<31-<54	<24	<38	<44	<30	<34	<31	<50	<50
Calcium	0.69	4		2,700-240,000	19,000	31,000	11,000	41,000	6,300	5,500	<200	<200
Chromium	0.066	1		9.3-33	9.0	5.4	8.9	9.8	10	13	<50	<50
Cobalt	N/A	1-8.8		<6.3-17	5.6J	<7.5J	<8.8	<5.9	<6.8	<6.1	<100	<100
Copper	0.045	1		12-71	9.1	5.7	13	8.5	26	20	<50	<50
Iron	0.50	2		5,400-39,000	18,000	14,000	12,000	8,100	9,300	15,000	100	<100
Lead	0.13	8.8-75		<9.5-7.0	<47	<75	<8.8	<59	<68	<61	<100	<100
Magnesium	0.96	4		1,000-34,000	4,200	5,300	2,100	11,000	1,300	1,700	<200	<200
Manganese	0.025	1		15J-1,000J	750J	260J	160	150	100	88	<50	<50
Molybdenum	N/A	2.4-4.4		<3.1-<35	<2.4	<3.8	<4.4	<3.0	<3.4	<3.1	<50	<50
Nickel	0.11	1		13-80	15	11	17	12	12	15	<50	<50
Potassium	23	100-440		<540-2,600	540J	<370J	<440	1,370	680	930	<5,000	<5,000

☐ CT&E Data.
N/A Not available.
J Result is an estimate.
R Result has been rejected.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Soil/Sediment
Units: mg/kg
METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank			Lab Blanks
					SD03 & SD08 (Replicates)		SD05	S05	S06 & S09 (Replicates)			EB02		
Laboratory Sample ID Numbers					4514-2	4514-7	4514-6	4514-11	4514-12	4514-13		4511-1		4514 4511
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		µg/L		µg/L
Selenium	1.2	47-88		<61-<110	<47	<75	<88	<59	<68	<61		<100		<100
Silver	0.53	24-44		<31-<54	<24R	<38R	<44	<30R	<34	<31		<50J		<50
Sodium	0.55	5		58-120	110	97	290	150	130	150		340		<250
Thallium	0.011	0.23-0.44		<0.31-<0.52	<0.23J	<0.39J	<0.44	<0.29J	<0.31	<0.36		<5		<5
Vanadium	0.036	1		19-58	18	14	18	17	25	28		<50		<50
Zinc	0.16	1		40J-250	49	36	57	73	70	45		<50		<50

☐ CT&E Data.
J Result is an estimate.
R Result has been rejected.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blank	Lab Blanks	
					5SD01	5SD02	5SD03-1	5SD04	5SD05	3EB02		
Laboratory Sample ID Numbers					2592-8	2592-9	2592-10	2592-11	2592-12	4742-2	4742	2592
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
PCBs	0.02	0.02-0.05	10	<0.02-20JN	<0.02	<0.03	<0.05	<0.03	<0.04	<1	<1	<0.02

☐ CT&E Data.
■ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blank	Lab Blanks	
					5SD06	5SD07	5SD08	5SD09	3EB02		
Laboratory Sample ID Numbers					2592-13	2592-14	2592-15	2592-16	4742-2	4742	2592
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
PCBs											
Aroclor 1260	0.020	0.02-0.04	10	<0.02-20JN	<0.04	<0.02	0.309	7.42	<1	<1	<0.02

☐ CT&E Data.
▩ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blank	Lab Blanks	
					5SD11	5SD12	5SD13	3EB02		
Laboratory Sample ID Numbers					2714-4	2714-5	2714-6	4742-2	4742	2714
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
PCBs	0.02	0.02-0.20	10	<0.02-20JN	<0.02	<0.09	<0.20	<1	<1	N/A

☐ CT&E Data.
▩ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
N/A Not available.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples							Field Blanks			Lab Blanks
					SW01	SW02	SW03	SW04	SW05	SW06 & SW07 (Duplicates)		AB01	EB02	TB02	
Laboratory Sample ID Numbers					1516/1543	1518/1544 4514-1 4512-4	1522/1545	1524/1546 4512-5 4514-8	1534/1549 4512-8 4514-14	1536/1550 4512-9 4514-5	1540/1551 4512-10 4514-16	4512-3	1510/1542 4512-1	1514 4512-2	#6-9393 #1&2-9493 4512 4514
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	100	1,000		<1,000[b]	<1,000J[b]	<1,000J[b]	<1,000J[b]	<1,000J[b]	<1,000J[b]	<1,000J[b]	<1,000J[b]	NA	<1,000J[b]	NA	NA
GRPH	5	50		<50J[b]	<50J[b]	<50J[b]	<50J[b]	<50J[b]	<50J[b]	<50J[b]	<50J[b]	NA	<50J[b]	<50J[b]	<50
RRPH (Approx.)	200	2,000		<2,000	<2,000	<2,000	<2,000	<2,000	<2,000	<2,000	<2,000	NA	<2,000	NA	NA
BTEX (8020/8020 Mod.)															
Benzene	0.1	1	5	<1[c]	5J	<1	5J	<1	<1	<1	<1	<1[c]	<1	<1	<1
Toluene	0.1	1	1,000	<1[c]	<1	<1	2	<1	<1	1	<1	<1[c]	<1	<1	<1
Ethylbenzene	0.1	1	700	<1[c]	2	<1	2	<1	<1	1	1	<1[c]	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2[c]	5J	<2	5J	<2	<2	4J	4J	<2[c]	<2	<2	<2
HVOC 8010															
Carbon Tetrachloride	0.1-0.2	1-2	5	<0.02J-<0.06J	<1J	<1J	<1J	<1J	<1J	1J	2J	NA	<1J	<1J	NA
Tetrachloroethene	0.1-0.2	1-2	5	<0.02J-<0.06J	<1J	<1J	4J	<1J	<1J	<1J	<1J	NA	<1J	<1J	NA
Trichloroethene	0.1-0.2	1-2	5	<0.02J-<0.06J	<1J	<1J	<1J	<1J	<1J	17J	21J	NA	<1J	<1J	NA
VOC 8260															
Carbon Tetrachloride	1	1	5	<1	NA	<1	NA	<1	NA	48	1.4	<1	<1	<1	<1
Chloroform	1	1		<1	NA	<1	NA	<1	NA	4.8	2.4	<1J	<1	<1	<1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples							Field Blanks			Lab Blanks
					SW01	SW02	SW03	SW04	SW05	SW06 & SW07 (Duplicates)		AB01	EB02	TB02	
Laboratory Sample ID Numbers					1516/1543	1518/1544 4514-1 4512-4	1522/1545	1524/1548 4512-5 4514-8	1534/1549 4512-8 4514-14	1538/1550 4512-9 4514-5	1540/1551 4512-10 4514-16	4512-3	1510/1542 4512-1	1514 4512-2	4512 4514
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
cis-1,2-Dichloroethene	1	1	70	<1	NA	<1	NA	<1	NA	1.2	1.5	<1J	<1	<1	<1
Trichloroethene	1	1	5	<1	NA	<1	NA	<1	NA	6.8	4.2	<1	<1	<1	<1
SVOC 8270	10	10-31		<10	NA	<11	NA	<31	<10	<11	NA	NA	<11	NA	<10
Pesticides	0.02-1	0.2-10		<0.2J-<10J	NA	NA	NA	<0.2J-<10	NA	NA	NA	NA	<0.2J-<10	NA	NA
PCBs	0.2	2	0.5	<2J	<2J	<2J	<2J	<2J	<2J	<2J	<2J	NA	<2J	NA	NA
TOC	5,000	5,000		<5,000-15,600	NA	10,200	NA	24,500	52,900	32,100	32,900	NA	NA	NA	<5,000
TSS	100	200		2,500-3,000	NA	2,500	NA	56,000	13,000	35,000	36,000	NA	NA	NA	<200
TDS	10,000	10,000		203,000-245,000	NA	236,000	NA	328,000	688,000	258,000	245,000	NA	NA	NA	<10,000

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Surface Water
Units: $\mu g/L$

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks
					2SW08	2SW09 & 2SW10 (Duplicates)					AB01	2EB04	2TB04	
Laboratory Sample ID Numbers					1915 4727-4 4729-1	1917 4727-7 4729-2	1918 4727-8 4729-3				4512-3	1924 4727-10	4727-9	#6-91393 4727 4512 4729
ANALYSES	$\mu g/L$	$\mu g/L$	$\mu g/L$	$\mu g/L$	$\mu g/L$	$\mu g/L$	$\mu g/L$				$\mu g/L$	$\mu g/L$	$\mu g/L$	$\mu g/L$
DRPH	100	1,000		<1,000[b]	<1,000[b]	<1,000[b]	<1,000[b]				NA	<1,000[b]	NA	<1,000
RRPH (Approx.)	400	4,000		<2,000	<4,000	<4,000	<4,000				NA	<4,000	NA	<4,000
VOC 8260														
Benzene	1	1	5	<1	1.2J	<1	<1				<1	<1J	<1J	<1
Carbon Tetrachloride	1	1	5	<1	89J	<1	<1				<1	<1J	<1J	<1
Chloroform	1	1		<1	16J	<1	<1				<1J	<1J	<1J	<1
Toluene	1	1	1,000	<1	9.6J	<1	<1				<1	<1J	<1J	<1
Trichloroethene	1	1	5	<1	62J	<1	<1				<1	<1J	<1J	<1
Xylenes (Total)	2	2	10,000	<2	3.3J	<2	<2				<2	<2J	<2J	<2
SVOC 8270	10	10-11		<10	<10[c]	<11	<11				NA	NA	NA	<10

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
c There were no analytes detected above quantitation limits in this sample, however, some of the surrogate recoveries for this sample were below the validation criteria.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Cape Lisburne Bkgd. Levels	Environmental Samples					Field Blank			Lab Blank
					SW02	SW04	SW05	SW06 & SW07 (Duplicates)			EB02		
Laboratory Sample ID Numbers					4511-2	4511-3	4511-6	4511-7	4511-8		4511-1		4511
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L
Aluminum	17.4	100		<100 (<100)	<100 (<100)	160 (<100)	<100 (<100)	130 (110)	150 (130)		<100 (<100)		<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)		<100 (<100)		<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)		<100 (<100)		<100 (<100)
Barium	1.2	50	2,000	79-92 (73-89)	77 (71)	210 (180)	860 (720)	460 (440)	490 (470)		<50 (<50)		<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Calcium	34.5	200		28,000-41,000 (28,000-41,000)	20,000 (19,000)	58,000 (58,000)	150,000 (140,000)	25,000 (27,000)	28,000 (23,000)		<200 (<200)		200 (<200)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)	<100 (<50)	<100 (<100)	<100 (<100)	<100 (<100)		<100 (<100)		<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Iron	25	100		<100-190 (<100)	470 (160)	1,600 (330)	4,900 (840)	1,300 (720)	4,000 (2,000)		100 (<100)		<100 (<100)
Lead	6.6	100	15	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)		<100 (<100)		<100 (<100)

☐ CT&E Data.
N/A Not available.

TABLE 4-1. LANDFILL AND WASTE ACCUMULATION AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Landfill and Waste Accumulation Area (LF01)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Cape Lisburne Bkgd. Levels	Environmental Samples					Field Blank			Lab Blank
					SW02	SW04	SW05	SW06 & SW07 (Duplicates)			EB02		
Laboratory Sample ID Numbers					4511-2	4511-3	4511-6	4511-7	4511-8		4511-1		4511
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L
Magnesium	47.8	200		4,500-9,000 (4,500-8,800)	8,700 (8,400)	14,000 (14,000)	30,000 (28,000)	9,900 (10,000)	10,000 (9,000)		<200 (<200)		200 (<200)
Manganese	1.24	50		<50 (<50)	<50 (<50)	730 (460)	1,800 (1,100)	90 (<50)	160 (76)		<50 (<50)		<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Potassium	1,154	5,000		<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)		<5,000 (<5,000)		<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)		<100 (<100)		<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)	<50J (<50J)	<50 (<50)	<50 (<50)	<50 (<50)		<50J (<50J)		<50 (<50)
Sodium	27.7	250		4,000-5,600 (3,900-6,000)	38,000 (38,000)	23,000 (23,000)	25,000 (23,000)	19,000 (18,000)	18,000 (17,000)		340 (380)		<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)		<5 (<5)		<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)
Zinc	8.2	50		<50-260 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)		<50 (<50)		<50 (<50)

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE 4-2. LANDFILL AND WASTE ACCUMULATION AREA (LF01) PCB IMMUNOASSAY TEST RESULTS

SAMPLE NUMBER	PHOTOMETER READING	PCB (ppm) FIELD SCREEN	PCB (ppm) LABORATORY
3S23	-0.41 -0.05	≥1 ≥10	NA
3S24-2	-0.14 0.21	≥1 <10	NA
3S25	-0.48 -0.42	≥1 ≥10	NA
3S26-2	-0.59 0.11	≥1 <10	NA
3S27	-0.42 0.01	≥1 <10	NA
3S28	-0.48 0.07	≥1 <10	NA
3S29-2	0.06 0.55	<1 <10	NA
3S30	-0.87 0.18	≥1 <10	NA
3S31-2	-0.91 -0.94	≥1 ≥10	999
3S32 Rep. of 3S27	-0.78 0.13	≥1 <10	NA
3S33 Rep. of 3S25	-0.89 -0.81	≥1 ≥10	NA
5S51	0.20 0.42	<1 <10	NA
5S52-1	0.54 0.35	<1 <10	NA
5S53	-0.96 -0.79	≥1 ≥10	NA
5S54-2	-0.96 -0.39	≥1 ≥10	NA
5S55	-1.10 -0.14	≥1 ≥10	29.7
5S56	-1.08 -0.14	≥1 ≥10	NA
5S57-1.5	-1.06 -0.96	≥1 ≥10	NA

TABLE 4-2. LANDFILL AND WASTE ACCUMULATION AREA (LF01) PCB IMMUNOASSAY TEST RESULTS (CONTINUED)

SAMPLE NUMBER	PHOTOMETER READING	PCB (ppm) FIELD SCREEN	PCB (ppm) LABORATORY
5S58	-1.08 -0.47	≥1 ≥10	11.4
5S59-2	-1.09 -0.03	≥1 ≥10	NA
5S60	-1.14 -0.97	≥1 ≥10	NA
5S61-2	-1.14 -1.06	≥1 ≥10	NA
5S62	-1.10 -0.27	≥1 ≥10	NA
5S63	0.15 0.75	<1 <10	NA
5S64	0.65 0.80	<1 <10	NA
5S65	0.67 0.73	<1 <10	0.999
5S66	0.28 0.88	<1 <10	NA
5S67	0.54 0.79	<1 <10	NA
5S68	0.46 0.88	<1 <10	0.798
5S69	0.44 0.74	<1 <10	NA
5S70	-1.13 -0.00/0.01/-0.02	≥1 Indetermanent	7.91

NA Not analyzed.

TABLE 4-3. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE LANDFILL AND WASTE ACCUMULATION AREA (LF01)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN*
						CANCER	NON-CANCER		
Landfill and Waste Accumulation Area (LF01)	Soil/Sediment	DRPH	18,600	mg/kg	<60-<150	--	--	500[c]	**Yes**
		GRPH	50.9	mg/kg	<2J-<6J	--	--	100[c]	No
		RRPH	43,100	mg/kg	<120-<300	--	--	2,000[c]	**Yes**
		Aroclor 1254	0.235	mg/kg	<0.02-<0.3	0.00831[d]	0.54	10[f]	No
		Aroclor 1260	999	mg/kg	<0.02-20JN	0.00831[d]	0.54[e]	10[f]	**Yes**
		Benzene	0.256	mg/kg	<0.02-<0.160	2.21	--	0.5[c]	No
		n-Butylbenzene	0.636	mg/kg	<0.025-<0.160	--	--	--	No
		sec-Butylbenzene	0.168	mg/kg	<0.025-<0.160	--	--	--	No
		Carbon Tetracholride	17.3	mg/kg	<0.02J-<0.160	0.492	18.9	--	**Yes**
		Chloroform	0.796	mg/kg	<0.025-<0.160	10.5	270	--	No
		cis-1,2-Dichloroethene	0.048	mg/kg	<0.025-<0.160	--	270	--	No
		Ethylbenzene	2.19	mg/kg	<0.02-<0.160	--	2,700	--	No
		Isopropylbenzene	0.242	mg/kg	<0.025-<0.160	--	--	--	No
		p-Isopropyltoluene	0.178	mg/kg	<0.025-<0.160	--	--	--	No

* The COCs selected for the site do not include metals that are considered essential human nutrients or analytes that do not have an RBSL or ARAR; however, these chemicals were discussed in the Cape Lisburne Risk Assessment (U.S. Air Force 1996).
< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
g MCL, 52 FR 25690 (08 Jul 87).
h MCL, 56 FR 3526 (30 Jan 91).
i MCL, 56 FR 30266 (01 Jul 91).
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-3. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE LANDFILL AND WASTE ACCUMULATION AREA (LF01) (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN*
						CANCER	NON-CANCER		
Landfill and Waste Accumulation Area (LF01) (Continued)	Soil/Sediment (Continued)	Methylene chloride	0.066	mg/kg	<0.02J-<0.160	8.53	1,620	--	No
		2-Methylnaphthalene	8.59	mg/kg	<0.25-<4.23	--	--	--	No
		4-Methylphenol	2.16	mg/kg	<0.25-<4.23	--	135	--	No
		Naphthalene	4.26J	mg/kg	<0.25-<4.23	--	1,100	--	No
		Phenol	0.920	mg/kg	<0.25-<4.23	--	16,200	--	No
		n-Propylbenzene	0.758	mg/kg	<0.025-<0.160	--	--	--	No
		Toluene	8.45	mg/kg	<0.02-<0.160	--	5,400	--	No
		Trichloroethene	15.3	mg/kg	<0.025-<0.160	5.8	--	--	**Yes**
		1,2,4-Trimethylbenzene	6.89	mg/kg	<0.025-<0.160	--	--	--	No
		1,3,5-Trimethylbenzene	2.04	mg/kg	<0.025-<0.160	--	--	--	No
		Xylenes	9.83	mg/kg	<0.04-<0.320	--	54,000	--	No
		Aluminum	6,000	mg/kg	4,700-17,000	--	--	--	No
		Barium	630	mg/kg	590-2,000	--	1,890	--	No

* The COCs selected for the site do not include metals that are considered essential human nutrients or analytes that do not have an RBSL or ARAR; however, these chemicals were discussed in the Cape Lisburne Risk Assessment (U.S. Air Force 1996).
< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
g MCL, 52 FR 25690 (08 Jul 87).
h MCL, 56 FR 3526 (30 Jan 91).
i MCL, 56 FR 30266 (01 Jul 91).
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-3. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE LANDFILL AND WASTE ACCUMULATION AREA (LF01) (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN*
						CANCER	NON-CANCER		
Landfill and Waste Accumulation Area (LF01) (Continued)	Soil/Sediment (Continued)	Calcium	41,000	mg/kg	2,700-240,000	--	--	--	No
		Chromium	9.8	mg/kg	9.3-33	--	135	--	No
		Cobalt	5.6J	mg/kg	<6.3-17	--	--	--	No
		Copper	13	mg/kg	12-71	--	999	--	No
		Iron	18,000	mg/kg	5,400-39,000	--	--	--	No
		Magnesium	11,000	mg/kg	1,000-34,000	--	--	--	No
		Manganese	750J	mg/kg	15J-1,000J	--	3,780	--	No
		Nickel	17	mg/kg	13-80	--	540	--	No
		Potassium	1,370	mg/kg	<540-2,600	--	--	--	No
		Sodium	290	mg/kg	58-120	--	--	--	No
		Vanadium	18	mg/kg	19-58	--	189	--	No
		Zinc	73	mg/kg	40J-250	--	8,100	--	No
		Benzene	5J	μg/L	<1	0.617	--	5[g]	**Yes**
		Carbon tetrachloride	89J	μg/L	<0.02J-<1	0.65	2.56	5[g]	**Yes**

* The COCs selected for the site do not include metals that are considered essential human nutrients or analytes that do not have an RBSL or ARAR; however, these chemicals were discussed in the Cape Lisburne Risk Assessment (U.S. Air Force 1996).
< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
g MCL, 52 FR 25690 (08 Jul 87).
h MCL, 56 FR 3526 (30 Jan 91).
i MCL, 56 FR 30266 (01 Jul 91).
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-3. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE LANDFILL AND WASTE ACCUMULATION AREA (LF01) (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN*
						CANCER	NON-CANCER		
Landfill and Waste Accumulation Area (LF01) (Continued)	Surface Water (Continued)	Chloroform	16J	µg/L	<1	13.9	36.5	100[i]	**Yes**
		cis-1,2-Dichloroethene	1.5	µg/L	<1	--	36.5	70	No
		Ethylbenzene	2	µg/L	<1	--	158	700[h]	No
		Tetrachloroethene	4J	µg/L	<0.02J-<1	1.43	36.5	5[h]	**Yes**
		Toluene	9.6J	µg/L	<1	--	96.5	1,000[h]	No
		Trichloroethene	21J	µg/L	<0.02J-<1	2.5	--	5[g]	**Yes**
		Xylene	5J	µg/L	<2	--	7,300	10,000[h]	No
		Aluminum	160	µg/L	<100	--	--	--	No
		Barium	860	µg/L	79-92	--	256	2,000[i]	No
		Calcium	150,000	µg/L	28,000-41,000	--	--	--	No
		Iron	4,900	µg/L	<100-190	--	--	--	No
		Magnesium	30,000	µg/L	4,500-9,000	--	--	--	No
		Manganese	1,800	µg/L	<50	--	18.3	--	**Yes**
		Sodium	38,000	µg/L	4,000-5,600	--	--	--	No

* The COCs selected for the site do not include metals that are considered essential human nutrients or analytes that do not have an RBSL or ARAR; however, these chemicals were discussed in the Cape Lisburne Risk Assessment (U.S. Air Force 1996).

< Indicates Not Detected.

a Risk-Based Screening Level.

b Applicable or Relevant and Appropriate Requirement.

c ADEC 1991.

d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).

e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.

f TSCA cleanup level.

g MCL, 52 FR 25690 (08 Jul 87).

h MCL, 56 FR 3526 (30 Jan 91).

i MCL, 56 FR 30266 (01 Jul 91).

J Result is an estimate.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

4.2 WHITE ALICE SITE (SS03)

4.2.1 Site Background

This site is a communications site that was deactivated in 1979. It is located in the Upper Camp area on the southwest corner of the installation. The equipment and furniture were removed from the site in 1980, but the structures remain. The structures include an approximately 115 feet by 60 feet radio relay building and two large White Alice "billboards" that look like outdoor movie screens. The radio relay building once had transformers that contained PCB oils. It is suspected that dielectric fluids containing PCBs were discharged to the surrounding surface soils in small quantities during maintenance of the facility equipment.

Previous sampling, conducted in 1992 by Air Force contractors, detected PCBs and low levels of VOCs and SVOCs in the soil/sediment at the site. A detailed list of contaminants, source areas, and concentrations previously detected is presented in the RI/FS Work Plan (U.S. Air Force 1993a).

The site-specific environmental setting describing the topography, surface water drainage, and soil types is presented in the discussion of potential migration pathways, Section 4.4.3.

4.2.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the White Alice Site. The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

4.2.2.1 Summary of Samples Collected. A total of 40 soil samples was collected at the White Alice Site (SS03). Sixteen samples were analyzed for PCBs by the laboratory. Eleven samples were also analyzed for DRPH and RRPH. Twenty-four samples were field screened for PCBs. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities. Locations of all samples collected at the White Alice Site (SS03) are presented in Figure 4-3.

4.2.2.2 Analytical Results. The data summary table (Table 4-4) presents analytical results for all samples collected at the site. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow comparison of naturally occurring organic compounds with samples collected from the site. Sample locations and analytical results for the samples collected at the site are illustrated in Figure 4-3. Table 45 presents the immunoassay field screening results for PCBs. All organic compounds detected are presented on the figure except when they were a result of laboratory contamination or field decontamination procedures. The exceptions are presented on the data summary table. The following section presents a discussion of organic compounds detected at the site.

Organics. Organic compounds detected in soil samples collected at the site are limited to DRPH and Aroclor 1260. DRPH were detected in one soil sample (sample 2S09-2.5) at 380 mg/kg.

Aroclor 1260 (a group of PCBs) was detected in nine samples ranging from 0.5 to 6,290 mg/kg. In addition, PCBs were detected at ≥10 mg/kg in eleven other soil samples using immunoassay field screening.

Inorganics. Metals were not a concern at the site, and no metals analyses were performed.

4.2.2.3 Summary of Site Contamination. The primary contaminants at the site are PCBs (Aroclor 1260). The source of contaminants detected during sampling conducted at the White Alice Site (SS03) is suspected to be dielectric fluids containing PCBs that were possibly discharged to the surrounding surface soils during maintenance of the facility equipment.

Contaminants previously detected in the site soil samples include Aroclor 1260 and very low levels of VOCs and SVOCs. Aroclor 1260 was previously detected at 114 mg/kg. Fifteen VOCs and SVOCs, probably components of the dielectric fluids which contained the PCBs, were detected at low concentrations ranging from 0.0004 to 2.7 mg/kg (Woodward-Clyde 1992).

During the current RI investigation, DRPH was detected at low levels (380 mg/kg) in one sample, and PCBs (Aroclor 1260) were detected ranging from 0.5 to 6,290 mg/kg.

A comparison of historical and current project data indicates higher concentrations of PCBs (Aroclor 1260) in the soils at the site. Because PCBs are relatively insoluble, tend not to break down, and tend to bind to soil particles, it is likely that concentrations are similar to those in the past. Differences between past and current data are likely to be the result of more extensive sampling during the 1993 RI. The suspected source of the PCBs (Aroclor 1260) detected at the White Alice Site is dielectric fluids containing PCBs that were possibly discharged to the surrounding surface soils during maintenance of facility equipment. The contaminated soil samples were collected adjacent to the doors of the White Alice building, and PCB affected soils appear to be localized. Based on field data, source of contamination, and concentration of contaminants, the area of affected soil is limited to approximately 2,800 square feet of the gravel pad/bedrock adjacent to the doors of the building. The human health and ecological risks associated with the chemicals detected at the site are presented in Sections 4.2.4 and 4.2.5.

4.2.3 Migration Pathways

This section describes the topography and stratigraphy of the site and the migration potential of contaminants from the site. A discussion of receptors and chemical concentrations at receptors is included.

4.2.3.1 Topography and Stratigraphy. The White Alice Site is located near the southeast edge of a 1,500 foot mountain top. The topography in the immediate vicinity of the site is fairly flat and consists of a rocky surface with minimal vegetation. There are no apparent drainage features in the area.

The stratigraphy at this site consists of subangular to angular rocks ranging up to seven inches in length in a sandy silt matrix (Section 2.4.4.2). The depth to permafrost in this area was not

determined because the materials were unsuitable for the hand augering; however, bedrock was probably present at a depth of approximately three feet.

4.2.3.2 Migration Potential.

Subsurface Migration. Topography indicates that any subsurface flow should be generally to the southeast. Because PCBs are relatively insoluble and were detected only in the shallow samples around the doors of the building, the potential for subsurface migration of contaminants is minimal.

Surface Migration. There are no distinct surface drainage features in the immediate vicinity of the site. Surface migration in this area should be limited to the spring thaw, when the abundant supply of meltwater and reduced infiltration could combine to form overland flow of runoff water to the southeast. Because PCBs were detected only around the doors of the building and are relatively insoluble, the potential for surface migration of contaminants is minimal.

Air Transport. Air transportation is not considered to be a significant mode of migration at the site (Section 2.4.4.5).

Summary of Migration Potential. The occurrence of PCBs at the site is limited to the areas around the doors of the White Alice building. Because PCBs are relatively insoluble and tend to bind to soil particles, the potential for migration of contaminants is minimal.

4.2.3.3 Receptors and Chemical Concentrations at Receptors.

Human Receptors. Potential human receptors at the White Alice Site include Air Force contractor personnel working at the station, visitors to the station, and an occasional local visitor passing the site to get to recreational or subsistence lands. Human receptors could potentially be exposed to the chemicals detected in soils/sediments at the site. The primary routes of potential exposure at the site are direct contact with, and incidental ingestion of, soils/sediments. Surface water was not considered a route of exposure because no surface waters are associated with the site. Groundwater and air at the Cape Lisburne sites are not considered complete pathways of exposure, so these media are not evaluated as potential pathways to human receptors.

The Cape Lisburne Risk Assessment (U.S. Air Force 1996) evaluates in detail the risks to human health from all COCs detected at the site. The potential receptor groups were selected based on their likelihood of exposure to contaminants at the site. The potential receptor groups evaluated include radar installation workers, and native adults and children who may visit the site. The estimated exposure point concentrations for human receptors are based on the maximum concentration of each chemical detected at the site. The potential risks to human health associated with site chemicals at Cape Lisburne are presented in Section 4.2.4.

Ecological Receptors. Ecological receptors were evaluated in detail in the Cape Lisburne Risk Assessment (U.S. Air Force 1996) to determine if plants and animals potentially could be affected by the chemicals detected at the Cape Lisburne installation. Because of the diversity of the

plants and animals in the area of the Cape Lisburne installation, a set of representative species were selected in the ERA for detailed evaluation. The species include plants, aquatic invertebrates, fish, birds, and mammals. These receptors were selected based primarily on their likelihood of exposure given their preferred habitat and feeding habits. The representative species encompass a range of ecological niches in order to achieve the best characterization of the ecosystems being examined and are presented in Table 2-6.

The estimate of chemical concentrations at the ecological receptors was based on the average site-wide concentration of each COC. This approach was appropriate because few of the representative species would inhabit only one distinct site at the installation; they are more likely to be exposed to the mix of chemicals and concentrations detected on all the sites at Cape Lisburne. The potential ecological risks associated with the chemicals detected at the site are presented in Section 4.2.5.

4.2.4 Human Health Risk Assessment

This section presents a summary of the potential human health risks associated with the chemicals detected at the White Alice Site (SS03). The purpose of the human health risk assessment is to quantify the excess lifetime cancer risk and/or the noncancer hazard (reported as hazard index) from the contaminants detected at the site.

This summary presents the COCs at the site, the pathways by which human receptors may be exposed to site chemicals, potential risks to human health posed by each chemical through each exposure pathway evaluated, the significance of the risk and/or hazard estimate, and a comparison of site chemical concentrations to ARARs. The methods and assumptions used in calculating hazards and risks are presented in Section 2.4.1.

4.2.4.1 Chemicals of Concern. At the White Alice Site (SS03), the only COC identified in the soil/sediment was Aroclor 1260 (a group of PCBs). No surface water bodies were associated with the site; therefore, no surface water samples were collected.

Table 4-6, Identification of COCs at the White Alice Site, presents the maximum concentrations of chemicals detected at the site and associated background concentrations, RBSLs, and ARARs, and identifies the COCs selected in the risk evaluation.

4.2.4.2 Exposure Pathways and Potential Receptors. Because no surface water bodies are associated with the White Alice Site, only soil/sediment ingestion pathways were considered in the risk assessment.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to a radar installation (worker), an adult inhabitant of communities in the North Slope of Alaska (native), and a child living in a North Slope community (child).

4.2.4.3 Risk Characterization.

Noncancer Hazard and Cancer Risk Associated with Soils and Sediments. The noncancer hazard associated with the ingestion of soil at the White Alice Site (SS03) by a hypothetical native northern adult/child is 381, and by radar a installation worker is 18, based on the maximum concentration of the COC. The presence of Aroclor 1260 accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of soil at the site by the hypothetical native northern adult/child is 9×10^{-3}, and by a radar installation worker is 4×10^{-4}, based on the maximum concentration of the COC. The presence of PCBs (Aroclor 1260) accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Noncancer Hazard and Cancer Risk Associated with Surface Water. No surface water bodies were identified at the White Alice Site (SS03). Therefore, there is no apparent surface water pathway, and no evaluation of noncancer hazard or excess lifetime cancer risk associated with ingestion of surface water at the site was conducted.

4.2.4.4 Summary of Human Health Risk Assessment. The presence of PCBs (Aroclor 1260) in the gravel pad at the White Alice Site (SS03) accounts for the quantifiable noncancer hazard and cancer risk. These risks and hazards were estimated based on ingestion of soil at a rate associated with a residential scenario. The affected gravel at the site is estimated at approximately 311 cubic yards, and it is very unlikely that soil at this location would be ingested at the conservative rate used in the risk calculation. In addition, the hazards and risks at the site are based on the maximum concentrations detected at the site. Therefore, the hazards and risks at the site are likely to be overestimated. However, the COCs identified at the White Alice site could potentially pose a threat to human health under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). Remedial action is generally warranted at sites where the excess lifetime cancer risk is $>1 \times 10^{-4}$, or the noncancer hazard significantly exceeds one (EPA 1991b). On the basis of cancer risk and noncancer hazards, remediation of the site is recommended.

4.2.5 Ecological Risk Assessment

The objective of the ERA was to estimate the potential impacts of chemicals detected at the installation to aquatic and terrestrial plants and animals. A summary of the methods used to assess potential ecological impacts is presented in Section 2.4.2.

4.2.5.1 Chemicals of Concern. COCs were selected based on criteria presented in Section 3.1 of the ERA. The average installation-wide concentrations of COCs were used to calculate the risk estimates. All sites at the installation were considered to be potentially usable habitat. It should be noted that the COC selection process only considered the soil/sediment samples that were 1.5 feet deep or less. The soil/sediment samples were screened for depth because it is unlikely that any of the representative species will be exposed to soils/sediments deeper than 1.5 feet. Of the chemicals detected in soils/sediments at the White Alice Site, DRPH, RRPH, and Aroclor 1260 were identified as COCs. Aroclor 1260 was the only COC associated with potential risk at the White Alice Site.

4.2.5.2 Exposure Pathways and Potential Receptors. Potential exposure pathways for terrestrial organisms include direct contact with, and ingestion of, contaminated soil/sediment. The most significant route of exposure for plants is direct contact with soil. Receptors may also be exposed to COCs through ingestion of plant and animal items in their diet, and incidental ingestion of soil/sediment while foraging, although these pathways are considered less significant and are not used to calculate HQs. Birds and mammals may be exposed to COCs through ingestion of surface water, ingestion of plant and animal diet items (although only ingestion of plant matter was quantified in the estimated exposure equation), and incidental ingestion of soil/sediment.

The potential ecological receptors evaluated in the risk assessment include plants, aquatic organisms, and birds, and mammals likely to occur along the Arctic Coastal Plain. Representative species from these receptor groups were selected based primarily on the species' likelihood of exposure, preferred habitat and feeding habits. Species that may be particularly sensitive to environmental impacts, such as threatened and endangered species, are considered on an individual basis if present at or near the installation. No sensitive species were identified (Alaska Biological Research 1994) or evaluated at the Cape Lisburne installation. The species evaluated in the ERA are listed in Table 2-6.

4.2.5.3 Risk Characterization. Potential risks at the White Alice Site are related to the elevated Aroclor 1260 HQs for the brant (1.7), glaucous gull (2.4), Lapland longspur (7), pectoral sandpiper (69), and brown lemming (69). HQs for the remaining COCs are below 1.0 for the other representative species.

4.2.5.4 Summary of Ecological Risk Assessment. Aquatic organisms were not evaluated at the site because no surface water is associated with the site. The PCB concentrations in soil at the White Alice Site contribute significantly to the elevated HQs for Aroclor 1260. Potential risks to the brant, glaucous gull, Lapland longspur, pectoral sandpiper, and brown lemming from Aroclor 1260 at the White Alice Site are estimated to be low to moderate. In addition, the future risks associated with Aroclor 1260 may be greater than current estimates because of the high potential for bioaccumulation of PCBs in the food chain.

4.2.6 Conclusions and Recommendation

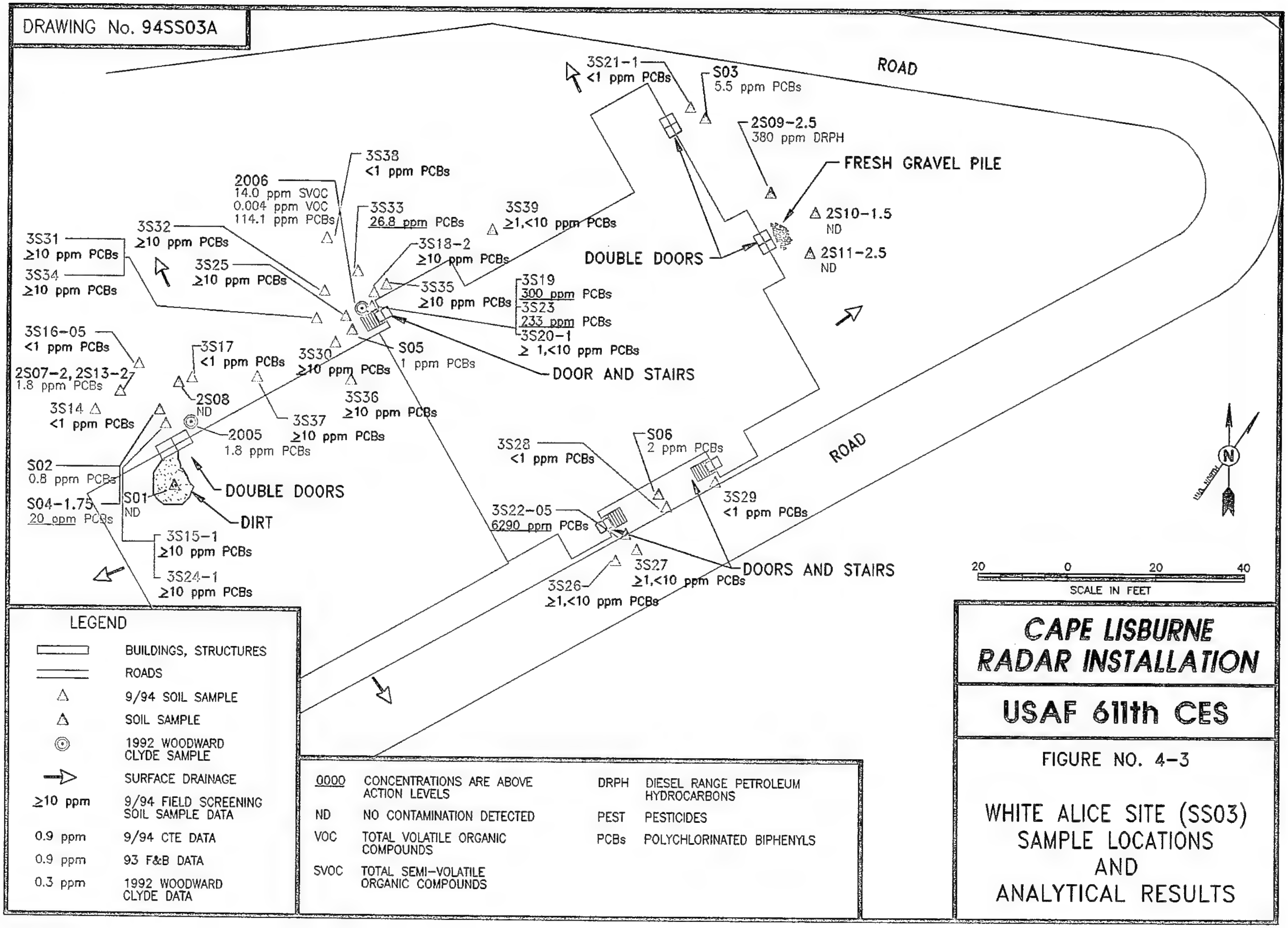
Sampling and analyses have determined that the White Alice Site (SS03) is contaminated with Aroclor 1260, a group of PCBs. The contaminated areas at the site are in the soils around the doors to the White Alice building. The source of contamination is likely to be dielectric fluids containing PCBs that were suspected to have been discharged to the surrounding surface soils in small quantities during maintenance of the facility equipment. The site is deactivated, and the transformers have been removed from this site.

Migration of contaminants from the site appears to have been minimal. Affected gravel is limited to approximately 2,800 square feet around the building adjacent to the doorways. The potential for migration of PCBs is not anticipated as the site is relatively flat and PCBs tend to bind tightly with soil particles.

The risk assessment concluded that risks to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action (i.e., cancer risk $>1 \times 10^{-4}$ and noncancer risk that significantly exceeds one). Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore, the site is being recommended for remedial action. The contaminated area at the site consists of approximately 311 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the Feasibility Study, Section 5.0.

THIS PAGE INTENTIONALLY LEFT BLANK


DRAWING No. 94SS03A
ROAD
ROAD
3S21-1
<1 ppm PCBs
S03
5.5 ppm PCBs
2S09-2.5
380 ppm DRPH
FRESH GRAVEL PILE
2S10-1.5
ND
2S11-2.5
ND
3S38
<1 ppm PCBs
2006
14.0 ppm SVOC
0.004 ppm VOC
114.1 ppm PCBs
3S33
26.8 ppm PCBs
3S39
≥1,<10 ppm PCBs
3S32
≥10 ppm PCBs
3S31
≥10 ppm PCBs
3S34
≥10 ppm PCBs
3S25
≥10 ppm PCBs
3S18-2
≥10 ppm PCBs
3S35
≥10 ppm PCBs
DOUBLE DOORS
3S19
300 ppm PCBs
3S23
233 ppm PCBs
3S20-1
≥ 1,<10 ppm PCBs
3S16-05
<1 ppm PCBs
3S17
<1 ppm PCBs
3S30
≥10 ppm PCBs
S05
1 ppm PCBs
DOOR AND STAIRS
2S07-2, 2S13-2
1.8 ppm PCBs
2S08
ND
3S36
≥10 ppm PCBs
3S14
<1 ppm PCBs
2005
1.8 ppm PCBs
3S37
≥10 ppm PCBs
S02
0.8 ppm PCBs
S01
ND
DOUBLE DOORS
S04-1.75
20 ppm PCBs
DIRT
3S15-1
≥10 ppm PCBs
3S24-1
≥10 ppm PCBs
3S28
<1 ppm PCBs
S06
2 ppm PCBs
3S22-05
6290 ppm PCBs
3S29
<1 ppm PCBs
3S27
≥1,<10 ppm PCBs
3S26
≥1,<10 ppm PCBs
DOORS AND STAIRS
N
20
0
20
40
SCALE IN FEET
LEGEND
BUILDINGS, STRUCTURES
ROADS
9/94 SOIL SAMPLE
SOIL SAMPLE
1992 WOODWARD CLYDE SAMPLE
SURFACE DRAINAGE
≥10 ppm 9/94 FIELD SCREENING SOIL SAMPLE DATA
0.9 ppm 9/94 CTE DATA
0.9 ppm 93 F&B DATA
0.3 ppm 1992 WOODWARD CLYDE DATA
0000 CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND NO CONTAMINATION DETECTED
VOC TOTAL VOLATILE ORGANIC COMPOUNDS
SVOC TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
DRPH DIESEL RANGE PETROLEUM HYDROCARBONS
PEST PESTICIDES
PCBs POLYCHLORINATED BIPHENYLS
CAPE LISBURNE RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 4-3
WHITE ALICE SITE (SS03) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 4-4 WHITE ALICE SITE ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne   Matrix: Soil
Site: White Alice Site (SS03)   Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank	Lab Blanks	
					S01	S02	S03	S04-1.75	S05	S06	EB01		
Laboratory Sample ID Numbers					1379	1394	1395	1396	1397	1398	1558/1561	#1&2-9493 #6-9393	#6-9293
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	5-6	50-60	500[a]	<60[b]-<150[b]	<60J[b]	<50[b]	<50J[b]	<50J[b]	<50[b]	<50J[b]	<1,000J[b]	<2,000	<50
RRPH (Approx.)	10-20	100-200	2,000[a]	<120-<300	<120	<110	<200	<100	<100	<110	<2,000	<4,000	<100
Pesticides	0.005-0.05	0.05-0.5	0.04	<0.01J-0.07R	NA	NA	NA	NA	NA	<0.05-<0.5	<0.2J-<10J	<0.2-<10	<0.01-<0.5
PCBs													
Aroclor 1260	0.001	0.1	10	<0.02-20JN	<0.1	0.8JN	5.5JN	20JN	1JN	2JN	<2J	<10	<0.1-<0.5

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
R Result has been rejected.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.

TABLE 4-4. WHITE ALICE SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: White Alice Site (SS03)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank	Lab Blanks	
					2S07-2 & 2S13-2 (Replicates)		2S08	2S09-2.5	2S10-1.5	2S11-2.5	2EB04		
Laboratory Sample ID Numbers					1908	1913	1909	1910	1911	1912	1924	#6-91393	#6-91393
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	5-10	50-100	500[a]	<60[b]-<150[b]	<50[b]	<100[b]	<50J[b]	380J[b]	<50J[b]	<50J[b]	<1,000[b]	<1,000	<50J
RRPH (Approx.)	10-20	100-200	2,000[a]	<120-<300	<100	<200	<100	<200	<100	<100	<4,000	<4,000	<100
PCBs													
Aroclor 1260	0.01	0.1	10	<0.02-20JN	0.5J	1.8J	<0.1	<0.1	<0.1	<0.1	<2	<10	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.

TABLE 4-4. WHITE ALICE SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne Matrix: Soil
Site: White Alice Site (SS03) Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blank	Lab Blanks	
					3S19 & 3S23 (Replicates)		3S22-0.5	3S33	3EB01		
Laboratory Sample ID Numbers					4608-11	4608-12	4608-13	4762-5	4608-5	4608 4762	4608
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	mg/kg	µg/L
PCBs											
Aroclor 1260	0.020	0.020	10	<0.02-20JN	300	233	6,290	26.8	<1.00	<0.03	<1

☐ CT&E Data.
▩ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-5. WHITE ALICE SITE (SS03) PCB IMMUNOASSAY TEST RESULTS

SAMPLE NUMBER	PHOTOMETER READING	PCB (ppm) FIELD SCREEN	PCB (ppm) LABORATORY
3S14	0.47 0.48	<1 <10	NA
3S15-1	-0.54 -0.54	≥1 ≥10	NA
3S16-0.5	0.45 0.58	<1 <10	NA
3S17	0.28 0.56	<1 <10	NA
3S18	-0.85 -0.69	≥1 ≥10	NA
3S19	-0.67 -0.66	≥1 ≥10	300
3S20-1	-0.84 0.03	≥1 <10	NA
3S21-1	0.36 0.37	<1 <10	NA
3S22-0.5	-0.84 -0.84	≥1 ≥10	6,290
3S23 Rep. of 3S19	-0.65 -0.66	≥1 ≥10	233
3S24-1 Rep. of 3S15-1	-0.55 -0.54	≥1 ≥10	NA
3S25	-0.54 -0.40	≥1 ≥10	NA
3S26	-0.72 0.39	≥1 <10	NA
3S27	-0.78 0.13	≥1 <10	NA
3S28	0.10 0.17	<1 <10	NA
3S29	0.36 0.68	<1 <10	NA
3S30	-0.78 -0.78	≥1 ≥10	NA
3S31	-0.78 -0.78	≥1 ≥10	NA

TABLE 4-5. WHITE ALICE SITE (SS03) PCB IMMUNOASSAY TEST RESULTS

SAMPLE NUMBER	PHOTOMETER READING	PCB (ppm) FIELD SCREEN	PCB (ppm) LABORATORY
3S32	-0.78 -0.79	≥1 ≥10	NA
3S33	-0.78 -0.55	≥1 ≥10	26.8
3S34 Rep. of 3S31	-0.90 -0.87	≥1 ≥10	NA
3S35	-0.90 -0.47	≥1 ≥10	NA
3S36	-0.90 -0.03	≥1 ≥10	NA
3S37	-0.43 -0.41	≥1 ≥10	NA
3S38	0.10 0.73	<1 <10	NA
3S39	-0.41 0.20	≥1 <10	NA

NA Not analyzed.

TABLE 4-6. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE WHITE ALICE SITE (SS03)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
White Alice Site (SS03)	Soil/ Sediment	DRPH	380J	mg/kg	<60-<150	--	--	500[c]	No
		Aroclor 1260	6,290	mg/kg	<0.1-20JN	0.00831[d]	0.540[e]	10[f]	**Yes**

< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

4.3 SPILL LEAK #3 (ST07)

4.3.1 Site Background

This site is located in the vicinity of the POL tanks, adjacent to the Arctic Ocean at the east end of the airstrip. The site consists of a bermed area around two POL tanks and the man-made hillside and drainage channel to the north. In August 1992 site personnel informed the ADEC that fuel had been observed seeping from the north hillside, downgradient from the POL tanks. Test pits were dug and approximately 25 gallons of fuel were collected. Leak tests were conducted, and site personnel determined that the tanks were not leaking (ADEC 1992). Visual observation made during the RI at this location showed a few gallons of diesel product floating in an approximately 2-foot by 5-foot polyethylene plastic-lined catchment area located at the base of the hillside north of the POL tanks. Oil absorbent booms have been laid across the drainage channel to collect diesel reaching the surface body. An IRA was conducted at this site during September 1994. An interception trench and collection and treatment system were installed to reduce the migration of diesel range petroleum from the hillside below the POL tanks to the drainage channel at the toe of the hill. The IRA activities at the site are discussed in detail in the Final Cape Lisburne IRA Report (U.S. Air Force 1995).

The site-specific environmental setting describing the topography, surface water drainage, and soil types is presented in the discussion of potential migration pathways, Section 4.3.3.

4.3.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the Spill/Leak #3 site. The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

4.3.2.1 Summary of Samples Collected. A total of 38 samples was collected at the site. These consisted of 29 soil samples, 7 sediment samples, and 2 surface water samples. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities and further RI characterization conducted in 1994. Locations of all samples collected at the Spill Leak #3 (ST07) site are presented in Figure 4-4.

Twenty-nine soil samples were analyzed for DRPH. In addition, 18 samples were analyzed for RRPH. Eleven samples were analyzed for GRPH. Five samples were analyzed for VOCs, and 21 samples were analyzed for BTEX.

Seven sediment samples were analyzed for DRPH and RRPH. In addition, five samples were analyzed for GRPH and BTEX. Four samples were analyzed for VOCs, and two samples were analyzed for SVOCs. One sample was analyzed for pesticides.

Two surface water samples were analyzed for DRPH, RRPH, VOCs, TSS, and TDS. In addition, one sample was analyzed for GRPH, SVOCs, pesticides, and TOC.

4.3.2.2 Analytical Results. The data summary table (Table 4-7) presents analytical results for all samples collected at the site. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow a direct comparison of naturally occurring organic compounds with samples collected from the site. Sample locations and analytical results for the samples at the site are illustrated in Figure 4-4. All organic compounds detected are presented on the figure except when they were a result of laboratory contamination or field decontamination procedures. The exceptions are presented on the data summary table.

The following section presents a discussion of organic compounds detected above background levels at the site. A discussion of TDS, TSS, and TOC is included.

Organics. Organic compounds detected in soil and sediment samples collected at the site include DRPH, GRPH, RRPH, BTEX compounds, fifteen other VOCs, and SVOCs. DRPH were detected in 22 samples ranging from 125 to 63,000 mg/kg. GRPH were detected in 10 samples ranging from 11 to 150 mg/kg. RRPH were detected in one sample (ST07-2S19) at 1,200 mg/kg. BTEX compounds were detected in 17 samples. Total BTEX ranged from 0.03 to 18.4 mg/kg; xylenes and ethylbenzene were the primary components. Nine other VOCs were detected in eight soil/sediment samples collected at the site at low concentrations ranging from 0.027 to 2.81 mg/kg. The primary VOCs detected are 1,2,4-trimethylbenzene (2.81 mg/kg) and 1,3,5-trimethylbenzene (1.76 mg/kg); both are common components of diesel fuel. Three SVOCs were detected in two sediment samples ranging from 2.29 to 7.32 mg/kg (ST07-SD01/SD06 and ST07-SD04).

In surface water samples only two VOCs were detected at low levels in sample ST07-SW01/SW03. The two VOCs detected were naphthalene (1.7 μg/L) and 1,2,4-trimethylbenene (1.2 μg/L).

Inorganics. Metals were not a concern at the site, and no metals analyses were performed.

In the duplicate surface water sample ST07-SW01/SW03, TDS, TSS, and TOC were reported at 376,000; 10,000; and 12,600 μg/L, respectively.

4.3.2.3 Summary of Site Contamination. The source of contaminants detected during sampling conducted at the Spill/Leak #3 site is suspected to be spills and/or leaks from the diesel storage tanks and piping. The predominant site contaminants are petroleum compounds (DRPH) and volatile components of petroleum. The POL tanks are scheduled to be decommissioned when the new tanks, presently under construction, are completed. The human health and ecological risks associated with the chemicals detected at the site are presented in Sections 4.3.4 and 4.3.5.

Based on field data, source of contamination, and concentration of the contaminants, the area of affected soil includes an area approximately 90,000 square feet north of the POL tanks; this includes the bermed area and hillside north of the tanks. An interception trench and collection and treatment system were installed in the hillside north of the POL tanks as part of IRA conducted in September 1994 to prevent the downgradient migration of petroleum compounds.

4.3.3 Migration Pathways

This section describes the topography and stratigraphy of the site and the migration potential of contaminants from the site. A discussion of receptors and chemical concentrations at receptors is included.

4.3.3.1 Topography and Stratigraphy. The Spill/Leak #3 (ST07) is located at the east end of the runway, north of the main station facilities. The site consists of the bermed area around the POL tanks, a steep hillside below the bermed area, and a drainage ditch at the base of the hillside. The drainage ditch drains the area below the hillslope and east end of the runway; this feature runs east along the south side of the runway then turns north and creates a ponded area. This ponded area flows north via a culvert and then infiltrates into the sandy subsurface before entering the sea.

The active layer at the site was approximately six feet thick during the 1993 RI. Gravel pad, road, and berm materials at this site were of the typical gravels and sands associated with these features, and subsurface tundra materials were of the typical stratigraphy found at Cape Lisburne (Section 2.4.4.2). Along the beach and east of the runway, subsurface materials consisted of the typical sands, gravels, and fine materials associated with beach deposits (Section 2.4.4.2).

4.3.3.2 Migration Potential.

Subsurface Migration. Analytical data indicate that subsurface soils are contaminated with petroleum hydrocarbons (diesel fuel). VOCs, GRPH, and RRPH were also detected at this site, but are primarily components of diesel. The presence of DRPH is subsurface soils outside of the berms area indicates that some subsurface migration has occurred, and subsurface migration may have been responsible for the free product which was noted during the RI on the surface of a catchment area at the base of the hillside.

Subsurface migration had occurred primarily in the hillside north of the site. The drainage ditch at the base of the hillside was receiving active layer water flow from the site. In these areas, any petroleum related contaminants were entering the ditch and being transported in surface water. Active layer water flow from the eastern tip of the site, however, was not intercepted by the ditch. Contamination detected in soil samples indicates that some migration occurred in this area, which may provide a direct pathway for subsurface migration to the Chukchi Sea. The steep hillside located below the POL tanks should result in a relatively steep gradient, and transport velocities in this area may be greater than at other sites where the topography is generally flat. Based upon these considerations, the potential for contaminant transport in subsurface water was considered to be high.

Due to the high potential for contaminant transport, an IRA was conducted at this site to capture spilled or leaked petroleum product (arctic grade diesel fuel) that was migrating through the subsurface downgradient of the POL tanks to the surface water body that flows to the Chukchi Sea. The IRA consisted of constructing a lined interception trench and collection and treatment system near the base of the hill below the POL tanks numbers 1 and 1A.

Surface Migration. Although surface water samples collected from the ditch were relatively uncontaminated, sediments in this feature were found to contain significant concentrations of DRPH. Because the ditch received the active layer water from the hillside and discharges directly to the Chukchi Sea, the potential for contaminant transport in surface water was considered to be high prior to the construction of the interception trench. The installation of the interception trench decreases the potential for migration of contaminants into the drainage ditch, which decreases the potential for surface migration of contaminants.

Air Transport. Air transportation is not considered to be a significant mode of migration at the site (Section 2.4.4.5).

Summary of Migration Potential. The analytical data indicate that soil and sediments at this site have been contaminated with DRPH. Based on the steep topography and contaminated soil/sediments samples, the potential for contaminants migration in subsurface water was considered to be high. Therefore, IRA activities were conducted that included construction of a lined interception trench and collection and treatment system to prevent downgradient migration of contaminants. A complete description of the IRA activities is presented in the IRA Report under a separate cover (U.S. Air Force 1995).

4.3.3.3 Receptors and Chemical Concentrations at Receptors.

Human Receptors. Potential human receptors at the Spill/Leak #3 (ST07) site include Air Force contractor personnel working at the station, visitors to the station, and an occasional local visitor passing the site to get to recreational or subsistence lands. Human receptors could potentially be exposed to the chemicals detected in surface water and soil/sediments at the site. The primary routes of potential exposures at the site are direct contact with soil/sediment, incidental ingestion of soil/sediment, and ingestion of surface water. Because groundwater and air at the Cape Lisburne sites are not considered complete pathways of exposure, these media are not evaluated as potential pathways to human receptors.

The Cape Lisburne Risk Assessment (U.S. Air Force 1996) evaluates in detail the risks to human health from all COCs detected at the site. The potential receptor groups were selected based on their likelihood of exposure to contaminants at the site, and include radar installation workers at the installation, and native adults and children who may visit the site. The estimated exposure point concentrations for human receptors are based on the maximum concentration of each chemical detected at the site. The potential risks to human health associated with chemicals detected at the site are presented in Section 4.3.4.

Ecological Receptors. Ecological receptors were evaluated in detail in the Cape Lisburne Risk Assessment (U.S. Air Force 1996) to determine if plants and animals could potentially be impacted by the chemicals detected at the Cape Lisburne installation. Because of the diversity of the plants and animals in the area of the Cape Lisburne installation, a set of representative species was selected in the ERA for detailed evaluation. The species include plants, aquatic invertebrates, fish, birds, and mammals. These receptors were selected based primarily on their likelihood of exposure given their preferred habitat and feeding habits. The representative

species encompass a range of ecological niches in order the achieve the best characterization of the ecosystems being examined and are presented in Table 2-6.

The estimate of chemical concentrations at the ecological receptors was based on the average site-wide concentration of each COC. This approach was appropriate because few of the representative species would inhabit only one distinct site at the installation; they are more likely to be exposed to the mix of chemicals and concentrations detected on all the sites at Cape Lisburne. The potential ecological risks associated with the chemicals detected at the site are presented in Section 4.3.5.

4.3.4 Human Health Risk Assessment

This section presents a summary of the potential human health risks associated with the chemicals detected at the Spill/Leak #3 (ST07) site. The purpose of the human health risk assessment was to quantify the excess lifetime cancer risk and/or the noncancer hazard (reported as hazard index) from the contaminants detected at the site.

This summary presents the COCs at the site, the pathways by which human receptors may be exposed to site chemicals, the potential risks to human health posed by each chemical through each exposure pathway evaluated, the significance of the risk and/or hazard estimate, and a comparison of site chemical concentrations to ARARs. The methods and assumptions used in calculating hazards and risks are presented in Section 2.4.1.

4.3.4.1 Chemicals of Concern. At the Spill/Leak #3 (ST07), COCs identified for the soil/sediment matrix included DRPH, GRPH, and benzene. DRPH, GRPH, and benzene were selected because maximum concentration exceeded ARARS. Table 4-8, Identification of COCs at the Spill/Leak #3 (ST07), presents the maximum concentrations of chemicals detected at the site and associated background concentrations, RBSLs, and ARARs, and identifies COCs selected in the risk evaluation.

4.3.4.2 Exposure Pathways and Potential Receptors. Because COCs were identified in soil/sediment and surface water at the Spill/Leak #3 (ST07) site, ingestion of soil/sediment and ingestion of surface water were evaluated in the risk assessment.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to a radar installation (worker), an adult inhabitant of communities in the North Slope of Alaska (native), and a child living in a North Slope community (child).

4.3.4.3 Risk Characterization.

Noncancer Hazard and Cancer Risk Associated with Soils and Sediments. The noncancer hazard associated with the ingestion of soil/sediment at the Spill/Leak #3 site by a hypothetical native northern adult/child is 1.0, and by a radar installation worker is 0.05, based on the maximum concentrations of the COCs. The presence of DRPH and GRPH accounts for the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of soil at the site by the hypothetical native northern

adult/child is 5×10^{-8}, and by a radar installation worker is 2×10^{-9}, based on the maximum concentrations of the COCs. The presence of GRPH and benzene accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Noncancer Hazard and Cancer Risk Associated with Surface Water. No COCs were identified for surface water at the site. The concentrations measured were below concentrations considered acceptable under Region 10 guidance (EPA 1991a) and ARARs.

Summary of Human Health Risk Assessment. The potential risks and hazards associated with the soil/sediment at the Spill/Leak #3 site are the very low noncancer hazard (hazard indices of 1.0 and 0.05), and very low cancer risk associated with the GRPH and benzene. The noncancer hazards were calculated conservatively based on a residential scenario; therefore, the noncancer hazards associated with soil/sediment at the site are minimal. The cancer risks are well below the threshold value of 1×10^{-6} and are also considered minimal (EPA 1991b).

In conclusion, under current uses and a future residential scenario, the COCs identified in soil/sediment at the Spill/Leak #3 site pose only a minimal, if any, potential threat to human health. Based on the human health risk assessment, remedial actions are not warranted at the site.

4.3.5 Ecological Risk Assessment

The objective of the ERA was to estimate the potential impacts of chemicals detected at the installation to aquatic and terrestrial plants and animals. A summary of the methods used to assess potential ecological impacts is presented in Section 2.4.2.

4.3.5.1 Chemicals of Concern. COCs were selected based on criteria presented in Section 3.1 of the ERA. The average installation-wide concentrations of COCs were used to calculate the risk estimates. All sites at the installation were considered to be potentially usable habitat. It should be noted that the COC selection process only considered the soil/sediment samples that were 1.5 feet deep or less. The soil/sediment samples were screened for depth because it is unlikely that any of the representative species will be exposed to soils/sediments deeper than 1.5 feet. Of the chemicals detected in surface water at the Spill/Leak #3 site, none were identified as COCs, but in soils/sediments, DRPH, GRPH, RRPH, benzene, toluene, xylenes, 1,4-dichlorobenzene, 4-methylphenol, and 1,2,4-trimethylbenzene were identified as COCs. None of the identified COCs were associated with elevated ecological risk estimates at the Spill/Leak #3 site.

4.3.5.2 Summary of Ecological Risk Assessment. Based on the calculated HQs, which are below 1.0 for all COCs and representative species, ecological risks at the Spill/Leak #3 site are minimal.

4.3.6 Conclusions and Recommendations

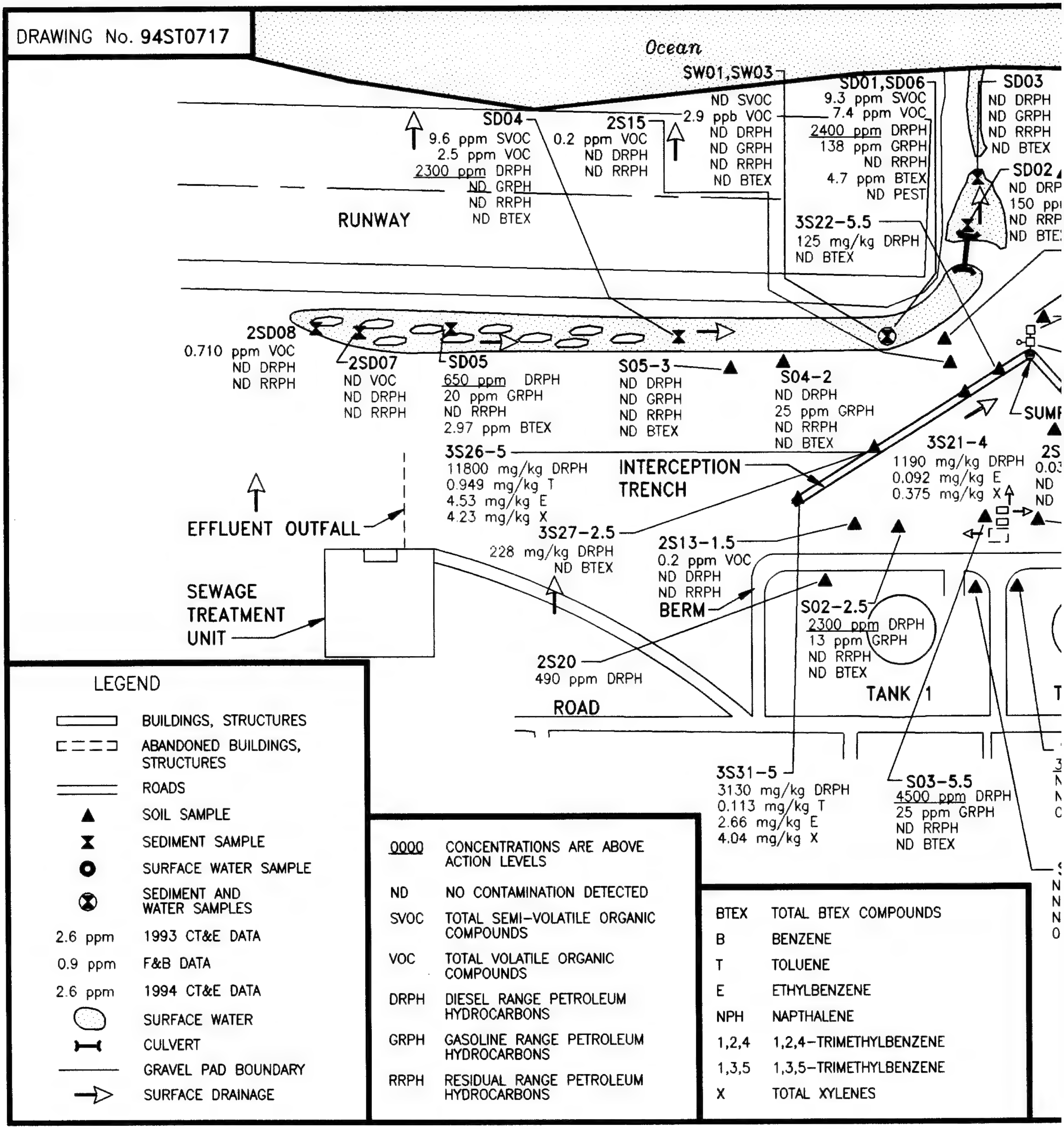
Sampling and analyses have determined that the Spill/Leak #3 (ST07) site is contaminated with petroleum hydrocarbons (DRPH) and volatile compounds, most of which are components of

diesel fuel. The affected areas at the site include the bermed area adjacent to the POL tanks, the hillside north of the berm, and soils in the man-made drainage ditch.

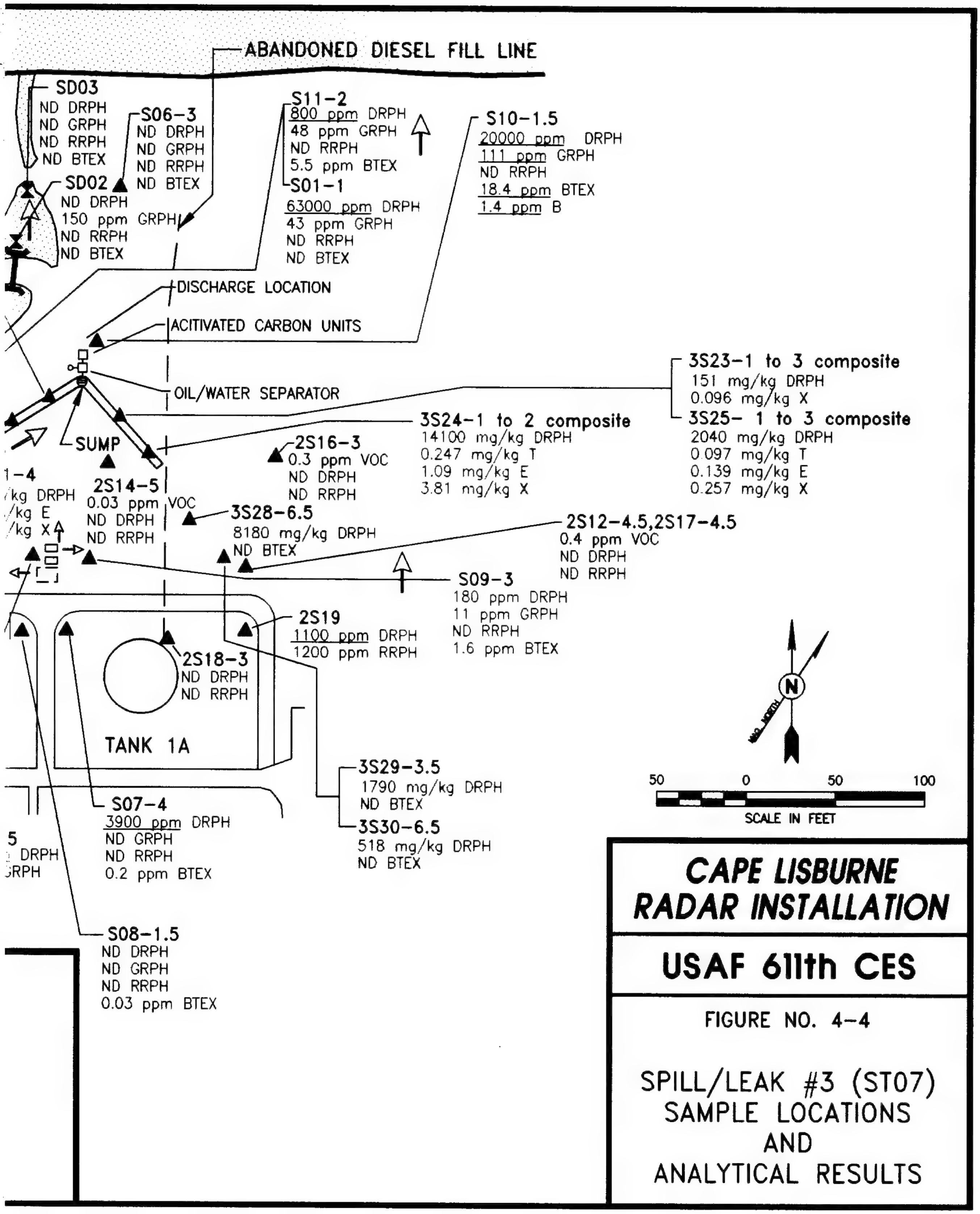
The risk assessment concluded that risks posed to human health and ecological receptors by site contaminants are minimal given current or future site uses. The potential human health risks at the site are not of a magnitude that normally requires remedial action. The ERA concluded that the overall potential risks presented by site contaminants are minimal. Therefore, under current site conditions and considering the findings of the risk assessment, remediation of the site is not necessarily warranted.

Levels of petroleum compounds (primarily diesel) detected in soil/sediment at the site exceed ADEC guidance cleanup levels. In addition, site contaminants have migrated downgradient of the site and have impacted gravel areas. Therefore, the site is being recommended for remedial action. The remedial action alternative recommended for the site is passive bioremediation. This is in addition to the interception trench and collection and treatment system which was installed in 1994. A complete description and evaluation of the remedial alternatives considered for this site are presented in the Feasibility Study, Section 5.0, and a complete description of the IRA activities conducted is presented in the IRA Report (U.S. Air Force 1995).

THIS PAGE INTENTIONALLY LEFT BLANK



DRAWING No. 94ST0717
Ocean
SW01,SW03
ND SVOC
2.9 ppb VOC
ND DRPH
ND GRPH
ND RRPH
ND BTEX
SD01,SD06
9.3 ppm SVOC
7.4 ppm VOC
2400 ppm DRPH
138 ppm GRPH
ND RRPH
4.7 ppm BTEX
ND PEST
SD03
ND DRPH
ND GRPH
ND RRPH
ND BTEX
SD04
9.6 ppm SVOC
2.5 ppm VOC
2300 ppm DRPH
ND GRPH
ND RRPH
ND BTEX
2S15
0.2 ppm VOC
ND DRPH
ND RRPH
RUNWAY
3S22-5.5
125 mg/kg DRPH
ND BTEX
2SD08
0.710 ppm VOC
ND DRPH
ND RRPH
2SD07
ND VOC
ND DRPH
ND RRPH
SD05
650 ppm DRPH
20 ppm GRPH
ND RRPH
2.97 ppm BTEX
S05-3
ND DRPH
ND GRPH
ND RRPH
ND BTEX
S04-2
ND DRPH
25 ppm GRPH
ND RRPH
ND BTEX
SUMP
3S21-4
1190 mg/kg DRPH
0.092 mg/kg E
0.375 mg/kg X
3S26-5
11800 mg/kg DRPH
0.949 mg/kg T
4.53 mg/kg E
4.23 mg/kg X
INTERCEPTION TRENCH
EFFLUENT OUTFALL
3S27-2.5
228 mg/kg DRPH
ND BTEX
2S13-1.5
0.2 ppm VOC
ND DRPH
ND RRPH
BERM
SEWAGE TREATMENT UNIT
S02-2.5
2300 ppm DRPH
13 ppm GRPH
ND RRPH
ND BTEX
2S20
490 ppm DRPH
ROAD
TANK 1
3S31-5
3130 mg/kg DRPH
0.113 mg/kg T
2.66 mg/kg E
4.04 mg/kg X
S03-5.5
4500 ppm DRPH
25 ppm GRPH
ND RRPH
ND BTEX
LEGEND
BUILDINGS, STRUCTURES
ABANDONED BUILDINGS, STRUCTURES
ROADS
SOIL SAMPLE
SEDIMENT SAMPLE
SURFACE WATER SAMPLE
SEDIMENT AND WATER SAMPLES
2.6 ppm 1993 CT&E DATA
0.9 ppm F&B DATA
2.6 ppm 1994 CT&E DATA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
0000 CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND NO CONTAMINATION DETECTED
SVOC TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
VOC TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH GASOLINE RANGE PETROLEUM HYDROCARBONS
RRPH RESIDUAL RANGE PETROLEUM HYDROCARBONS
BTEX TOTAL BTEX COMPOUNDS
B BENZENE
T TOLUENE
E ETHYLBENZENE
NPH NAPTHALENE
1,2,4 1,2,4-TRIMETHYLBENZENE
1,3,5 1,3,5-TRIMETHYLBENZENE
X TOTAL XYLENES



CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 4-4

SPILL/LEAK #3 (ST07) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S01-1	S02-2.5	S03-5.5	S04-2	S05-3	S06-3	AB01	EB03	TB03		
Laboratory Sample ID Numbers					1656	1658	1660	1662	1612	1614	4512-3	1625/1628	1626	4512 #6-9393 #1&2-9493	#6-9393 #3&4-9493
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-6	50-60	500[a]	<60[b]-150[b]	63,000[b]	2,300[b]	4,500[b]	<50[b]	<60[b]	<50[b]	NA	<1,000[b]	NA	<2,000	<50
GRPH	0.1-0.9	1-9	100	<2J[b]-<6J[b]	43J[b]	13J[b]	25J[b]	25J[b]	<9J[b]	<1J[b]	NA	<50J[b]	<50J[b]	<50	<1-<20
RRPH (Approx.)	10-200	100-2,000	2,000[a]	<120-<300	<2,000	<100	<100	<100	<120	<100	NA	<2,000	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	<3.6	<2.5	<0.28	<4.12	<1.04	<1.0					
Benzene	0.002-0.07	0.02-0.7	0.5	<0.02-<0.08	<0.4	<0.7	<0.02	<0.02	<0.02	<0.2	<1[c]	<1	<1	<1	<0.02-<0.2
Toluene	0.002-0.07	0.02-0.7		<0.02-<0.08	<0.4	<0.7	<0.02	<0.5	<0.2	<0.2	<1[c]	<1	<1	<1	<0.02-<0.2
Ethylbenzene	0.002-0.2	0.02-2		<0.02-<0.08	<2	<0.8	<0.04	<0.6	<0.02	<0.2	<1[c]	<1	<1	<1	<0.02-<0.2
Xylenes (Total)	<0.02-<0.3	<0.2-<3		<0.04-<0.12	<0.8	<0.5	<0.2	<3	<0.8	<0.4	<2[c]	<2	<2	<2	<0.04-<0.4

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S07-4	S08-1.5	S09-3	S10-1.5	S11-2	AB01	EB03	TB03		
Laboratory Sample ID Numbers					1616	1618	1620	1622	1624	4512-13	1625/1628	1626	4512 #6-9393 #1&2-9493	#6-9393 #3&4-9493
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	<60[b]-<150[b]	3,900[b]	<50[b]	180[b]	20,000[b]	800[b]	NA	<1,000[b]	NA	<2,000	<50
GRPH	0.1	1	100	<2J[b]-<6J[b]	<1J[b]	<1J[b]	11J[b]	111J[b]	48J[b]	NA	<80J[b]	<80J[b]	<50	<1-<20
RRPH (Approx.)	10-16	100-160	2,000[a]	<120-<300	<100	<100	<100	<160	<100	NA	<2,000	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	0.18J	0.03	1.6J	18.4J	5.5J					
Benzene	0.002-0.04	0.02-0.4	0.5	<0.02-<0.06	<0.02	<0.02	<0.02	1.4J	<0.02	<1[c]	<1	<1	<1	<0.02-<0.2
Toluene	0.002-0.04	0.02-0.4		<0.02-<0.06	0.03	0.03	0.4	<0.3	<0.02	<1[c]	<1	<1	<1	<0.02-<0.2
Ethylbenzene	0.002-0.04	0.02-0.4		<0.02-<0.06	0.05J	<0.03	0.6	7	3.2J	<1[c]	<1	<1	<1	<0.02-<0.2
Xylenes (Total)	0.004-0.08	0.04-0.8		<0.04-0.12	0.1J	<0.06	0.8J	10J	2.3J	<2[c]	<2	<2	<2	<0.04-<0.4

☐ CT&E Data.
▒ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX was determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne — Matrix: Soil
Site: Spill/Leak #3 (ST07) — Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: 2S12-4.5 & 2S17-4.5 (Replicates)		2S13-1.5	2S14-5	2S15	2S16-3	Field Blanks: AB01	2EB04	2TB04	Lab Blanks	
Laboratory Sample ID Numbers					1929 4728-15	1934 4728-20	1930 4728-16	1931 4728-17	1932 4728-18	1933 4728-19	4512-3	1924 4727-10	4727-9	#6-91393 4727 4512	#6-91393 4728
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-7	60-70	500[a]	<60[b]-<150[b]	<60J[b]	<60J[b]	<60[b]	<70J[b]	<70J[b]	<70J[b]	NA	<1,000[b]	NA	<1,000	<50J
RRPH (Approx.)	12-14	120-140	2,000[a]	<120-<300	<120	<120	<120	<140	<140	<140	NA	<4,000	NA	<4,000	<100
VOC 8260															
1,4-Dichlorobenzene	0.020	0.025		<0.025-<0.160	<0.025J	<0.025	<0.025	<0.025	0.095	<0.025	<1	<1J	<1J	<1	<0.025
Ethylbenzene	0.020	0.025		<0.025-<0.160	0.030J	<0.025	<0.025	<0.025	<0.025	<0.025	<1	<1J	<1J	<1	<0.025
Naphthalene	0.020	0.025		<0.025-<0.160	<0.025J	0.068	0.035	0.027	<0.025	0.038	<1	<1J	<1J	<1	<0.025
Toluene	0.020	0.025		<0.025-<0.160	0.045J	0.029	0.033	<0.025	<0.025	0.036	<1	<1J	<1J	<1	<0.025
Trichloroethene	0.020	0.025		<0.025-<0.160	<0.025J	<0.025	<0.025	<0.025	0.059	<0.025	<1	<1J	<1J	<1	<0.025
1,2,4-Trimethylbenzene	0.020	0.025		<0.025-<0.160	0.087J	0.108	0.078	<0.025	0.030	0.051	<1	<1J	<1J	<1	<0.025
1,3,5-Trimethylbenzene	0.020	0.025		<0.025-<0.160	0.048J	0.059	<0.025	<0.025	<0.025	0.037	<1	<1J	<1J	<1	<0.025
Xylenes (Total)	0.040	0.050		<0.050-<0.320	0.155J	0.116	0.055[d]	<0.500	0.043[d]	0.132	<2	<2J	<2J	<2	<0.050

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d Result is indicative of p&m-xylenes only.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank		Lab Blanks	
					2S18-3	2S19	2S20					2EB04		
Laboratory Sample ID Numbers					1935	1936	1937					1924	#6-91393	#6-91393
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L	mg/kg
DRPH	7.0	70	500[a]	<60[b]-<150[b]	<70[b]	1,100J[b]	490J[b]					<1,000[b]	<1,000	<50J
RRPH (Approx.)	14-20	140-200	2,000[a]	<120-<300	<140	1,200	<200					<4,000	<4,000	<100

▩ F&B Data.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					3S21-4	3S22-5.5	3S23 & 3S25 1' to 3' Composite (Replicates)		3S24 1' to 2' Composite	LF01 AB01	ST07 3TB01	3EB03		
Laboratory Sample ID Numbers					4639-5	4639-6	4639-7	4639-9	4639-8	4762-1	4639-3	4639-4	4639 4762	4639
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	<60[b]-<150[b]	1,190	125	151	2,040	14,100	NA	NA	<100	<100	<4.00
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	0.467	<0.125	0.096	0.493	5.147					
Benzene	0.020	0.025-0.030	0.5	<0.02-<0.06	<0.030	<0.025	<0.025	<0.025	<0.025	<1[c]	<1	<1	<1	<0.020
Toluene	0.020	0.025-0.030		<0.02-<0.06	<0.030	<0.025	<0.025	0.097	0.247	<1[c]	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.025-0.030		<0.02-<0.06	0.092	<0.025	<0.025	0.139	1.09	<1[c]	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.050-0.060		<0.04-<0.12	0.375	<0.050	0.096	0.257	3.81	<2[c]	<2	<2	<2	<0.040

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blank	
					3S26-5	3S27-2.5	3S28-6.5	3S29-3.5	3S30-6.5	3S31-5	LF01 AB01	ST07 3TB01	3EB03		
Laboratory Sample ID Numbers					4639-10	4639-11	4639-12	4639-13	4639-14	4639-15	4762-1	4639-3	4639-4	4639 4762	4639
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	<60[b]-<150[b]	11,800	228	8,180	1,790	518	3,130	NA	NA	<100	<100	<4.0
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	7.811	<0.100	<0.125	<0.100	<0.125	6.813					
Benzene	0.020	0.020-0.025	0.5	<0.02-<0.06	<0.025	<0.020	<0.025	<0.020	<0.025	<0.025	<1[c]	<1	<1	<0.5-<1	<0.020
Toluene	0.020	0.020-0.025		<0.02-<0.06	0.949	<0.020	<0.025	<0.020	<0.025	0.113	<1[c]	<1	<1	<0.5-<1	<0.020
Ethylbenzene	0.020	0.020-0.025		<0.02-<0.06	4.53	<0.020	<0.025	<0.020	<0.025	2.68	<1[c]	<1	<1	<0.5-<1	<0.020
Xylenes (Total)	0.040	0.040-0.050		<0.04-<0.12	4.23	<0.040	<0.050	<0.040	<0.050	4.04	<2[c]	<2	<2	<1-<2	<0.040

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel (DRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)
Matrix: Sediment
Units: mg/kg

Parameters	Detect Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					SD01 & SD06 (Replicates)		SD02	SD03	SD04	SD05	AB01	EB03	TB03		
Laboratory Sample ID Numbers					1644	1654	1646	1648	1650	1652	4512-3	1625/1628	1626	#6-9393 #1&2-9493 4512	#6-9393 #6-91093 #3&4-9493
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6	60	500^a	<60^b-<150^b	1,400^b	2,400^b	<60^b	<60^b	2,300^b	650^b	NA	<1,000^b	NA	<2,000	<50
GRPH	1.3-2.0	13-20	100	<2J^b-<6J^b	138J^b	14J^b	150J^b	<20J^b	<13J^b	20J^b	NA	<50J^b	<50J^b	<50	<1-<20
RRPH (Approx.)	12-20	120-200	2,000^a	<120-<300	<120	<130	<120	<120	<200	<200	NA	<2,000	NA	<4,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.1-<0.3	4.7J	2.5J	<1.04	<2.64J	<1.36	2.97J					
Benzene	0.002-0.004	0.02-0.04	0.5	<0.02-<0.06	<0.02	0.3	<0.02	<0.02	<0.02	<0.04	<1^c	<1	<1	<1	<0.02-<0.2
Toluene	0.002-0.004	0.02-0.04		<0.02-<0.06	<0.02	0.3	<0.02	<0.02	<0.04	0.07	<1^c	<1	<1	<1	<0.02-<0.2
Ethylbenzene	0.002-0.08	0.02-0.8		<0.02-<0.06	0.9	0.6	<0.8	<0.8J	<0.4	0.9	<1^c	<1	<1	<1	<0.02-<0.2
Xylenes (Total)	0.004-0.18	0.04-1.8		<0.04-<0.12	3.8J	1.4J	<0.4	<1.8J	<0.9	2J	<2^c	<2	<2	<2	<0.04-<0.4

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The actions level for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)
Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					SD01 & SD06 (Replicates)		SD04			AB01	EB03	TB03		
Laboratory Sample ID Numbers					1644 4814-8	1654 4814-10	1650 4814-9			4512-3	1625 4814-2	4814-1	4512/4814 #6-8393	4814 #6-8393
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L	µg/L	µg/L	µg/L	mg/kg
VOC 8260														
sec-Butylbenzene	0.020	0.025-0.050		<0.025-<0.160	0.370J	<0.025J	<0.050			<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.025-0.050		<0.025-<0.160	0.242J	0.134J	0.072			<1	<1	<1	<1	<0.020
Isopropylbenzene	0.020	0.025-0.050		<0.025-<0.160	0.210J	0.085J	<0.050			<1	<1	<1	<1	<0.020
p-Isopropyltoluene	0.020	0.025-0.050		<0.025-<0.160	0.762J	0.435J	0.157			<1	<1	<1	<1	<0.020
n-Propylbenzene	0.020	0.025-0.050		<0.025-<0.160	0.366J	0.149J	0.053			<1	<1	<1	<1	<0.020
Toluene	0.020	0.025-0.050		<0.025-<0.160	0.074J	0.037J	0.047			<1	<1	<1	<1	<0.020
Trichloroethene	0.020	0.025-0.050		<0.025-<0.160	<0.025	<0.025	0.426			<1	<1	<1	<1	<0.020
1,2,4-Trimethylbenzene	0.020	0.025-0.050		<0.025-<0.160	2.81	1.97	0.953			<1	<1	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.025-0.050		<0.025-<0.160	1.76	1.27	0.546			<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.050-0.100		<0.050-<0.320	0.776J	0.548J	0.295			<2	<2	<2	<2	<0.040
SVOC 8270														
di-n-Butylphthalate	0.200	0.311-8.20	8,000	1.61U-20.4JB	NA	6.74U	31.5JB			NA	NA	NA	NA	0.800
2-Methyl-naphthalene	0.200	0.311-8.20		<0.250-<4.23	NA	5.12J	2.29J			NA	NA	NA	NA	<0.200
4-Methylphenol	0.200	0.311-8.20		<0.250-<4.23	NA	<0.311J	7.32J			NA	NA	NA	NA	<0.200
Naphthalene	0.200	0.311-8.20		<0.250-<4.23	NA	4.18J	<8.20			NA	NA	NA	NA	<0.200
Pesticides	0.001	0.01		<0.01-0.07	<0.01	<0.01	NA			NA	<0.2-<10	NA	<0.2-<10	<0.01

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
U Compound is not presented above the concentration listed.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks	
					2SD07	2SD08			AB01	2EB04	2TB04		
Laboratory Sample ID Numbers					1938 4738-13	1939 4728-14			4512-3	1924 4727-10	4727-9	#6-91393 4727 4512	#6-91393 4728
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	10	100	500[a]	<60[b]-<150[b]	<100J[b]	<100J[b]			NA	<1,000[b]	NA	<1,000	<50J
RRPH (Approx.)	20	200	2,000[a]	<120-<300	<200	<200			NA	<4,000	NA	<4,000	<100
VOC 8260													
p-Isopropyltoluene	0.020	0.140-0.200		<0.025-<0.160	<0.200J	0.145			<1	<1J	<1J	<1	<0.200
Napthalene	0.020	0.140-0.200		<0.025-<0.160	<0.200J	0.380			<1	<1J	<1J	<1	<0.200
1,2,4-Trimethylbenzene	0.020	0.140-0.200		<0.025-<0.160	<0.200J	0.185			<1	<1J	<1J	<1	<0.200

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: SW01 & SW03 (Duplicates)				Field Blanks: AB01	EB03	TB03	Lab Blanks
Laboratory Sample ID Numbers					1631/1632 4614-3	1639/1640 4614-5			4512-3	1625/1628	1626	#6-9393 #1&2-9493 4614
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			µg/L	µg/L	µg/L	µg/L
DRPH	100	1,000		<1,000[b]	<1,000[b]	<1,000[b]			NA	<1,000[b]	NA	<2,000
GRPH	5	50		<50J[b]	<50J[b]	<50J[b]			NA	<50J[b]	<50J[b]	<50
RRPH (Approx.)	200	2,000		<2,000	<2,000	<2,000			NA	<2,000[b]	NA	<4,000
BTEX (8020/8020 Mod.)												
Benzene	0.1	1	5	<1[c]	<1[c]	<1[c]			<1[c]	<1	<1	<1
Toluene	0.1	1	1,000	<1[c]	<1[c]	<1[c]			<1[c]	<1	<1	<1
Ethylbenzene	0.1	1	700	<1[c]	<1[c]	<1[c]			<1[c]	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2[c]	<2[c]	<2[c]			<2[c]	<2	<2	<2
VOC 8260												
Naphthalene	1	1		<1	1.5	1.7			<1	<1	<1	<1
1,2,4-Trimethylbenzene	1	1		<1	1.1	1.2			<1	<1	<1	<1
SVOC 8270	10	11		<10	<11	<11			NA	NA	NA	<10

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.

TABLE 4-7. SPILL/LEAK #3 ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Spill/Leak #3 (ST07)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks
					SW01 & SW03 (Duplicates)				AB01	EB03	TB03	
Laboratory Sample ID Numbers					1631/1632 4614-3	1639/1640 4614-5			4512-3	1625/1628	1626	4614
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			µg/L	µg/L	µg/L	µg/L
Pesticides	0.02-1.0	0.2-10		<0.2J-<10J	<0.2-<10	<0.2-<10			NA	<0.2-<10	NA	NA
TOC	5,000	5,000		<5,000-15,600	12,000	12,600			NA	NA	NA	<5,000
TSS	100	200		2,500-3,000	9,000	10,000			NA	NA	NA	<200
TDS	10,000	10,000		203,000-245,000	369,000	376,000			NA	NA	NA	<10,000

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE 4-8. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE SPILL/LEAK #3 (ST07)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Spill/Leak #3 (ST07)	Soil/Sediment	DRPH	63,000	mg/kg	<60-150	--	--	500[c]	**Yes**
		GRPH	150	mg/kg	<2J-<6J	--	--	100[c]	**Yes**
		RRPH	1,200	mg/kg	<120-<300	--	--	2,000[c]	No
		Benzene	1.4J	mg/kg	<0.02-<0.160	2.21	--	0.5[c]	**Yes**
		sec-Butylbenzene	0.37J	mg/kg	<0.025-<0.160	--	--	--	No
		1,4-Dichlorobenzene	0.095	mg/kg	<0.025-<0.160	--	0.267	--	No
		Ethylbenzene	7	mg/kg	<0.02-<0.160	--	2,700	--	No
		Isopropylbenzene	0.21J	mg/kg	<0.025-<0.160	--	--	--	No
		p-Isopropyltoluene	0.762J	mg/kg	<0.025-<0.160	--	--	--	No
		2-Methylnaphthalene	5.12J	mg/kg	<0.250-<4.23	--	--	--	No
		4-Methylphenol	7.32J	mg/kg	<0.250-<4.23	--	135	--	No
		Naphthalene	4.18J	mg/kg	<0.025-<4.23	--	1,100	--	No
		n-Propylbenzene	0.366J	mg/kg	<0.025-<0.160	--	--	--	No
		Toluene	0.949	mg/kg	<0.02-<0.160	--	5,400	--	No
		Trichloroethene	0.426	mg/kg	<0.02J-<0.160	58	--	--	No
		1,2,4-Trimethylbenzene	2.81	mg/kg	<0.025-<0.160	--	--	--	No
		1,3,5-Trimethylbenzene	1.76	mg/kg	<0.025-<0.160	--	--	--	No
		Xylene	10J	mg/kg	<0.04-<0.320	--	54,000	--	No
	Surface Water	Naphthalene	1.7	µg/L	<1	--	146	--	No
		1,2,4-Trimethylbenzene	1.2	µg/L	<1	--	--	--	No

< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
J Result is an estimate.

4.4 UPPER CAMP TRANSFORMER BUILDING (SS08)

4.4.1 Site Background

The Upper Camp Transformer Building (SS08) site consists of a small abandoned building that previously housed electrical transformers. This site is located approximately 30 feet northeast of the radome in the Upper Camp. The site consists of an approximately 35 feet by 45 feet building placed on a gravel pad and bedrock. The building has a gravel floor with a concrete pad in the center. The transformers have been removed from the building; however, staining is apparent on the concrete pad and on the adjacent gravel within the building.

The site-specific environmental setting describing the topography, surface water drainage, and soil types is presented in the discussion of potential migration pathways, Section 4.4.3.

4.4.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the Upper Camp Transformer Building (SS08) site. The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

4.4.2.1 Summary of Samples Collected. A total of 8 soil samples was collected at the Upper Camp Transformer Building (SS08) site. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities and further characterization conducted in 1994. Locations of all samples collected at the Upper Camp Transformer Building (SS08) site are presented in Figure 4-5.

The 8 soil samples collected in the gravel adjacent to the concrete pad and by the doorway were analyzed for PCBs. Seven samples were also analyzed for DRPH and RRPH, and one sample was analyzed for TOC.

4.4.2.2 Analytical Results. The data summary table (Table 4-9) presents analytical results for all samples collected at the site. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow comparison of naturally occurring organic compounds with samples collected from the site. Sample locations and analytical results for the samples collected at the site are illustrated in Figure 4-5. All organic compounds detected are presented on the figure except when they were a result of laboratory contamination or field decontamination procedures. The exceptions are presented on the data summary table. The following section presents a discussion of organic compounds detected at the site.

Organics. Organic compounds detected in soil samples collected at the site are limited to DRPH, RRPH, and PCBs (Aroclors 1254 and 1260). DRPH were detected in five samples ranging from 50 to 51,000 mg/kg. RRPH were detected in five samples ranging from 250 to 29,000 mg/kg. PCBs (Aroclors 1254 and 1260) were as detected in five samples ranging from 0.9 to 300 mg/kg.

Inorganics. Metals were not a concern at the site, and no metals analyses were performed.

4.4.2.3 Summary of Site Contamination. The suspected source of the PCBs, Aroclors 1254 and 1260, detected during sampling conducted at the Upper Camp Transformer Building (SS08) is spills and/or leaks from the transformer that was previously located at the site. The affected soil samples were collected adjacent to the concrete pad on which the transformer was located. PCB contamination was not detected below one foot deep, so the affected area appears to be localized. No previous sampling had been conducted at the site. Based on field data, source of contamination and concentration of contaminants, the area of significantly contaminated soil is limited to 250 square feet of the gravel area adjacent to the concrete pad. The human health and ecological risks associated with the chemicals detected at the site are presented in Sections 4.4.4 and 4.4.5.

4.4.3 Migration Pathways

This section describes the topography and stratigraphy of the site and the migration potential of contaminants from the site. A discussion of receptors and chemical concentrations at receptors is included.

4.4.3.1 Topography and Stratigraphy. The transformer building contains a concrete pad in the center of the room which is surrounded by gravel/bedrock on all four sides. A covered walkway leads from the southeast wall of the building to adjacent abandoned facilities. The building is located next to the active radome and approximately 10 feet south of a steep cliff.

The stratigraphy at this site consists of subrounded to angular rocks ranging up to seven inches in length in a sandy silt matrix. Bedrock at this site was encountered at a depth of approximately 1.5 feet.

4.4.3.2 Migration Potential.

Subsurface Migration. Although DRPH, RRPH, and PCBs were detected at high concentrations inside of the building, analytical data indicate that no contaminants were detected outside of the building at a concentration which exceeded an action level. Contaminants inside of the building probably are not subject to significant migration because the building is covered and the inside is not open to precipitation. Because of the small active layer water flux in this area (Section 2.4.4.2) and the low solubility of PCBs, the potential for contaminant transport in the subsurface at this site is considered to be minimal.

Surface Migration. Analytical data indicate that significant surface contaminants are present only inside of the transformer building. Because this area is not open to precipitation, there are no surface drainage features in the area, and the relative insolubility of PCBs, the potential for contaminant transport in surface water is considered to be low.

Air Transport. Air transportation is not considered to be a significant mode of migration at the site (Section 2.4.4.5).

Summary of Migration Potential. Analytical data indicate that affected area is limited to the gravels within the Upper Camp Transformer Building. Because PCBs are relatively insoluble, tend to bind with soil particles, and there is minimal active layer water flow through the area, the potential for subsurface contaminants transport is considered to be low. The potential for contaminant transport in surface water is also considered to be low.

4.4.3.3 Receptors and Chemical Concentrations at Receptors.

Human Receptors. Potential human receptors at the Upper Camp Transformer Building (SS08) site include Air Force contractor personnel working at the station, visitors to the station, and an occasional local visitor passing the site to get to recreational or subsistence lands. Human receptors could potentially be exposed to the chemicals detected in soils/sediments at the site. The primary routes of potential exposures at the site are direct contact with soils/sediments and incidental ingestion of soils/sediments. Surface water was not considered a route of exposure at the site because no surface waters are associated with the site. Because groundwater and air at the Cape Lisburne sites are not considered complete pathways of exposure, these media are not evaluated as potential pathways to human receptors.

The Cape Lisburne Risk Assessment (U.S. Air Force 1996) evaluates in detail the risks to human health from all COCs detected at the site. The potential receptor groups were selected based on their likelihood of exposure to contaminants at the site, and include radar installation workers at the installation, and native adults and children who may visit the site. The estimated exposure point concentrations for human receptors are based on the maximum concentration of each chemical detected at the site. The potential risks to human health associated with site chemicals at Cape Lisburne are presented in Section 4.5.4.

Ecological Receptors. Ecological receptors were evaluated in detail in the Cape Lisburne Risk Assessment (U.S. Air Force 1996) to determine if plants and animals could potentially be impacted by the chemicals detected at the Cape Lisburne installation. Because of the diversity of the plants and animals in the area of the Cape Lisburne installation, a set of representative species were selected in the ERA for detailed evaluation. The species include plants, aquatic invertebrates, fish, birds, and mammals. These receptors were selected based primarily on their likelihood of exposure given their preferred habitat and feeding habits. The representative species encompass a range of ecological niches in order to achieve the best characterization of the ecosystems being examined and are presented in Table 2-6.

The estimate of chemical concentrations at the ecological receptors was based on the average site-wide concentration of each COC. This approach was appropriate because few of the representative species would inhabit only one distinct site at the installation; they are more likely to be exposed to the mix of chemicals and concentrations detected on all the sites at Cape Lisburne. The potential ecological risks associated with the chemicals detected at the site are presented in Section 4.4.5.

4.4.4 Human Health Risk Assessment

This section presents a summary of the potential human health risks associated with the chemicals detected at the Upper Camp Transformer Building (SS08) site. The purpose of the human health risk assessment is to quantify the excess lifetime cancer risk and/or the noncancer hazard (reported as hazard index) from the contaminants detected at the site.

This summary presents the COCs at the site, the pathways by which human receptors may be exposed to site chemicals, potential risks to human health posed by each chemical through each exposure pathway evaluated, the significance of the risk and/or hazard estimate, and a comparison of site chemical concentrations to ARARs. The methods and assumptions used in calculating hazards and risks are presented in Section 2.4.1.

4.4.4.1 Chemicals of Concern. At the Upper Camp Transformer Building (SS08), COCs identified in the soil/sediment included DRPH, RRPH, and PCBs (Aroclor 1254 and 1260). DRPH and RRPH were selected as COCs because the maximum concentrations detected exceeded ARARs. PCBs (Aroclor 1254 and 1260) were selected as a COC because the maximum concentration detected exceeded the RBSL and ARAR. There were no surface water bodies associated with the site.

Table 4-10, Identification of COCs at the Upper Camp Transformer Building (SS08), presents the maximum concentrations of chemicals detected at the site and associated background concentrations, RBSLs, and ARARs, and identifies the COCs selected in risk evaluation.

4.4.4.2 Exposure Pathways and Potential Receptors. Because no surface water bodies are associated with the Upper Camp Transformer Building (SS08) site, only soil/sediment ingestion pathways were considered in the risk assessment.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to a radar installation (worker), an adult inhabitant of the North Slope of Alaska (native), and a child living in a North Slope community (child).

4.4.4.3 Risk Characterization.

Noncancer Hazard and Cancer Risk Associated with Soils and Sediments. The noncancer hazard associated with the ingestion of soil at the Upper Camp Transformer Building (SS08) site by a hypothetical native northern adult/child is 21, and by a radar installation worker is 1.0, based on the maximum concentration of the COCs. The presence of Aroclor 1254 and 1260 accounts for 99 percent of the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of soil at the site by the hypothetical native northern adult/child is 4×10^{-4}, and by a radar installation worker is 2×10^{-5}, based on the maximum concentration of the COCs. The presence of DRPH, RRPH, and PCBs (Aroclor 1254 and 1260) accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Noncancer Hazard and Cancer Risk Associated with Surface Water. No surface water bodies were identified at the Upper Camp Transformer Building (SS08). Therefore, there is no apparent surface water pathway, and no evaluation of noncancer hazard or excess lifetime cancer risk associated with ingestion of surface water at the site was conducted.

4.4.4.4 Summary of Human Health Risk Assessment. The presence of DRPH, RRPH, and PCBs (Aroclors 1254 and 1260) in the gravel pad at the Upper Camp Transformer Building (SS08) accounts for the quantifiable noncancer hazard and cancer risk. These risks and hazards were estimated based on ingestion of soil at a rate associated with a residential scenario. The affected gravel at the site is estimated at approximately 28 cubic yards, and it is very unlikely that soil at this location would be ingested at the conservative rate used in the risk calculation. In addition, the hazards and risks at the site are based on the maximum concentrations detected at the site. Therefore, the hazards and risks at the site are likely to be overestimated. However, the COCs identified at the Upper Camp Transformer Building could pose a threat to human health under the condition posed in the Risk Assessment (U.S. Air Force 1996). Remedial action is generally warranted at sites where the excess lifetime cancer risk is $>1 \times 10^{-4}$ or the noncancer hazard significantly exceeds one (EPA 1991b). On the basis of cancer risk and noncancer hazard, remediation of the site is warranted.

4.4.5 Ecological Risk Assessment

The objective of the ERA was to estimate the potential impacts of chemicals detected at the installation to aquatic and terrestrial plants and animals. A summary of the methods used to assess potential ecological impacts is presented in Section 2.4.2.

4.4.5.1 Chemicals of Concern. COCs were selected based on criteria presented in Section 3.1 of the ERA. The average installation-wide concentrations of COCs were used to calculate the risk estimates. All sites at the installation were considered to be potentially usable habitat. It should be noted that the COC selection process only considered the soil/sediment samples that were 1.5 feet deep or less. The soil/sediment samples were screened for depth because it is unlikely that any of the representative species will be exposed to soils/sediments deeper than 1.5 feet. Of the chemicals detected in soils/sediments at the Upper Camp Transformer Building, DRPH, RRPH, Aroclor 1254, and Aroclor 1260 were identified as COCs. There were no surface water bodies associated with the site. Aroclor 1254 and Aroclor 1260 are associated with elevated risk estimates for ecological receptors.

4.4.5.2 Exposure Pathways and Potential Receptors. Potential exposure pathways for terrestrial organisms include direct contact with, and ingestion of, contaminated soil/sediment. The most significant route of exposure for plants is direct contact with soil. Receptors may also be exposed to COCs through ingestion of plant and animal items in their diet, and incidental ingestion of soil/sediment while foraging, although these pathways are considered less significant and are not used to calculate HQs. Birds and mammals may be exposed to COCs through ingestion of surface water, ingestion of plant and animal diet items (although only ingestion of plant matter was quantified in the estimated exposure equation), and incidental ingestion of soil/sediment.

The potential ecological receptors evaluated in the risk assessment include plants, aquatic organisms, and birds and mammals likely to occur along the Arctic Coastal Plain. Representative species from these receptor groups were selected based primarily on the species' likelihood of exposure, preferred habitat and feeding habits. Species that may be particularly sensitive to environmental impacts, such as threatened and endangered species, are considered on an individual basis if present at or near the installation. No sensitive species were identified (Alaska Biological Research 1994) or evaluated at the Cape Lisburne installation. Since there are no surface water bodies associated with the site, so aquatic organisms and the ingestion of surface water pathways were not evaluated for this site. The species evaluated in the ERA are listed in Table 2-6.

4.4.5.3 Risk Characterization. Potential risks at the Upper Camp Transformer Building are related to the elevated HQs for Aroclor 1254 and Aroclor 1260. Specifically, the HQs for Aroclor 1254 are 1.8 for the brant, 7 for the pectoral sandpiper, and 7 for the brown lemming. The HQs for Aroclor 1260 are 1.7 for the brant, 2.4 for the glaucous gull, 7 for the Lapland longspur, 69 for the pectoral sandpiper, and 69 for the brown lemming. HQs for the remaining COCs are below 1.0 for the other representative species.

4.4.5.4 Summary of Ecological Risk Assessment. No aquatic species were evaluated at the site because no surface water is associated with the site. The PCB concentrations at the Upper Camp Transformer Building contribute significantly to the elevated HQs for Aroclor 1254 and Aroclor 1260. The risk estimates for Aroclor 1254 and Aroclor 1260 are based on the toxicity of Aroclor 1254, which has been shown to be slightly more toxic. As a result, the risk estimates are grouped low to moderate for the glaucous gull, brant, pectoral sandpiper, brown lemming, and Lapland longspur. In addition, the future risks associated with PCBs may be greater than current estimates because of the high potential for PCB bioaccumulation in the food chain.

4.4.6 Conclusions and Recommendation

Sampling and analyses have determined that the Upper Camp Transformer Building (SS08) site is contaminated with DRPH, RRPH, and PCBs (Aroclors 1254 and 1260). The contaminated area at the site is the gravel area adjacent to the concrete pad on which a transformer was previously located. The likely source of contamination is previous spills and/or leaks of transformer fluid. The transformer and equipment was removed from the building when it was deactivated.

Migration of contaminants from the site appears to have been minimal. Contaminated gravel is limited to approximately 250 square feet within the building to the north and east of the concrete transformer pad. The potential for migration of contaminants is not anticipated as the site is relatively flat, PCBs are relatively insoluble and tend to bind tightly with soil particles, and the area is enclosed in a building where there is minimal surface or subsurface migration.

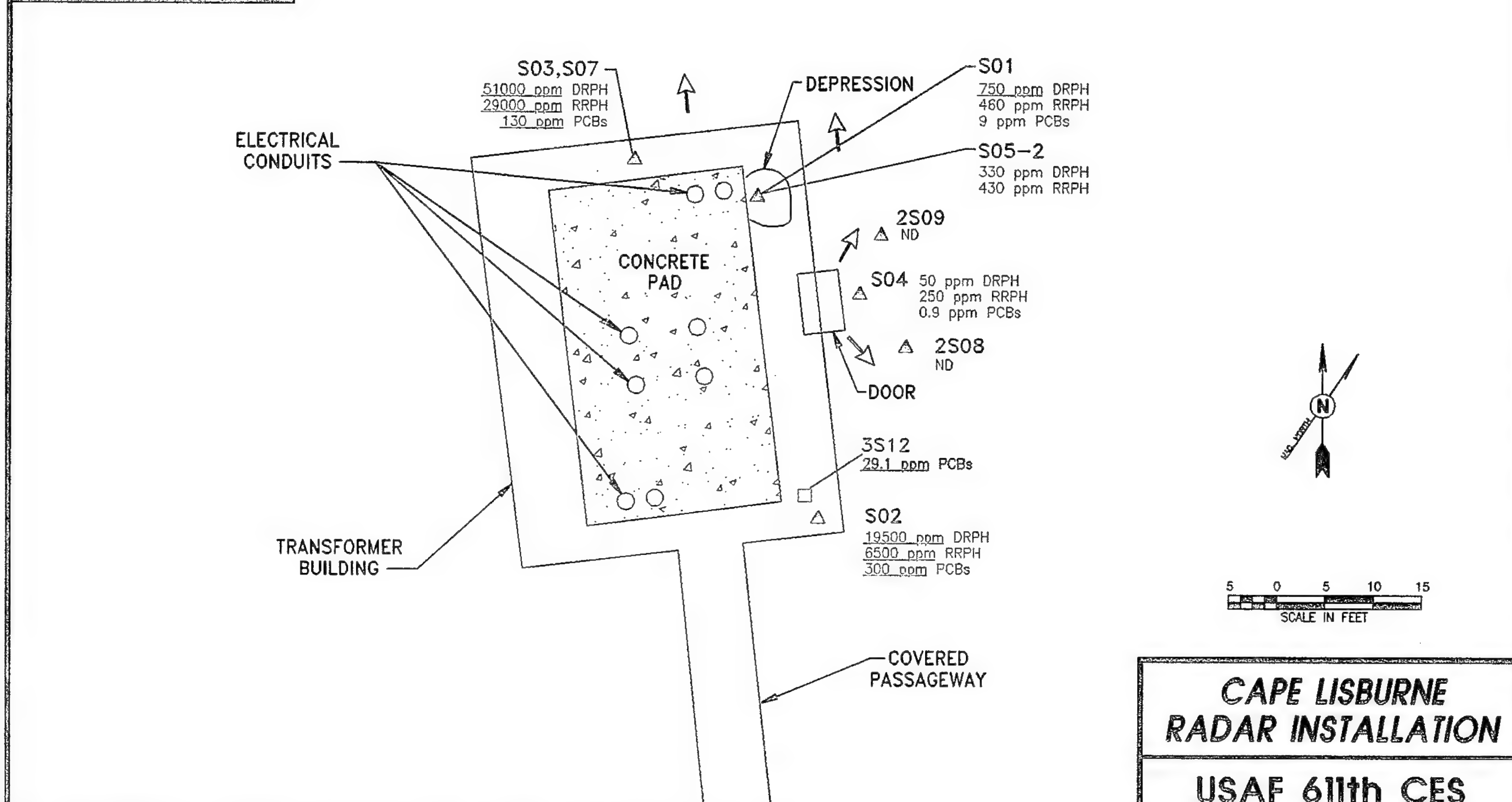
The risk assessment concluded that risks posed to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action [i.e., cancer risk is $>1 \times 10^{-4}$ and noncancer hazard is

significantly >1 (EPA 1991b)]. Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore, the site is being recommended for remedial action. The contaminated area at the site consists of approximately 28 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the Feasibility Study, Section 5.0.

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. 94SS08A



LEGEND

▭	BUILDINGS, STRUCTURES
□	94 SOIL SAMPLE
△	SOIL SAMPLE
⇾	SURFACE DRAINAGE
0.9 ppm	F&B DATA
0.9 ppm	9/94 CTE DATA

0000	CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND	NO CONTAMINATION DETECTED
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
RRPH	RESIDUAL RANGE PETROLEUM HYDROCARBONS
PCBs	POLYCHLORINATED BIPHENYLS

CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 4-5
UPPER CAMP TRANSFORMER BUILDING (SS08) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 4-9. UPPER CAMP TRANSFORMER BUILDING ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne
Site: Upper Camp Transformer Building (SS08)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank	Lab Blanks	
					S01	S02	S03 & S07 (Replicates)		S04	S05-2	EB01		
Laboratory Sample ID Numbers					1399	1400	1401	1404 4477-4	1402	1403	1558/1561	#1&2-9493 #6-9393	#6-9293 #6-9593
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	5.0	50	500[a]	<60[b]-<150[b]	750J[b]	19,500J[b]	51,000J[b]	49,000J[b]	50J[b]	330J[b]	<1,000J[b]	<2,000	<50
RRPH (Approx.)	N/A	N/A	2,000[a]	<120-<300	460	6,500	29,000	4,300	250	430	<2,000	<4,000	<100
PCBs													
Aroclor 1260	0.01-0.1	0.1-1	10	<0.02-20JN	9JN	300JN[d]	130JN	8JN	0.9JN	<0.1	<2J	<10	<0.1
TOC				25,700-77,900	NA	NA	NA	67,300	NA	NA	NA	NA	NA

☐ CT&E Data.
▩ F&B Data.
N/A Not available.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d The laboratory reported the results were outside of the calibration range.

TABLE 4-9. UPPER CAMP TRANSFORMER BUILDING ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Upper Camp Transformer Building (SS08)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks		Lab Blanks	
					2S08	2S09	3S12			2EB04	3EB01		
Laboratory Sample ID Numbers					1940	1941	4608-4			1924	4608-5	#6-91393 4608	#6-91393 4608
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	<60[b]-<150[b]	<100J[b]	<50[b]	NA			<1,000[b]	NA	<1,000	<50J
RRPH (Approx.)	10	100	2,000[a]	<120-<300	<100	<100	NA			<4,000	NA	<4,000	<100
PCBs													
Aroclor 1254	0.01-0.020	0.020-0.1	10	<0.02-<0.3	<0.1	<0.1	29.1			<2	<1.00	<10	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.

TABLE 4-10. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE UPPER CAMP TRANSFORMER BUILDING (SS08)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Upper Camp Transformer Building (SS08)	Soil/Sediment	DRPH	51,000J	mg/kg	<60-<150	--	--	500[c]	**Yes**
		RRPH	29,000	mg/kg	<120-<300	--	--	2,000[c]	**Yes**
		Aroclor 1254	29.1	mg/kg	<0.02-<0.3	0.00831[d]	0.540	10[f]	**Yes**
		Aroclor 1260	300JN	mg/kg	<0.1-20JN	0.00831[d]	0.540[e]	10[f]	**Yes**

< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

THIS PAGE INTENTIONALLY LEFT BLANK

4.5 LOWER CAMP TRANSFORMER BUILDINGS (SS09)

4.5.1 Site Background

This site is composed of two inactive transformer buildings placed on a gravel pad located approximately 100 feet northwest of the main composite building in the Lower Camp. Both buildings have a gravel floor with a concrete pad in the center. Staining is apparent on the concrete pads and on the adjacent soils in both buildings. Station personnel indicate that these buildings contained several PCB-bearing electrical transformers. The transformers have been removed from the building, but some support structures still remain.

The site-specific environmental setting describing the topography, surface water drainage, and soil types is presented in the discussion of potential migration pathways, Section 4.5.3.

4.5.2 Field Sampling and Analytical Results

This section describes the RI sampling and analytical results for samples collected at the Lower Camp Transformer Buildings (SS09) site. The discussion presents a review of laboratory data, data summary tables, contaminants identified, contaminant trends, and information on suspected source areas.

4.5.2.1 Summary of Samples Collected. A total of 12 soil samples was collected at the site. Table 2-2 presents a detailed summary of the samples collected and the analyses performed during the 1993 RI field activities and further characterization conducted in 1994. Locations of all samples collected at the Lower Camp Transformer Buildings (SS09) site are presented in Figure 4-6.

The twelve soil samples were analyzed for PCBs. In addition, ten samples were analyzed for DRPH and RRPH. One sample was analyzed for pesticides.

4.5.2.2 Analytical Results. The data summary table (Table 4-11) presents analytical results for all samples collected at the site. Detection and quantitation limits, action levels, associated laboratory and field blanks, and background analytical results are presented for each of the analyses. Background levels are listed to allow direct comparison of naturally occurring organic compounds with samples collected from the site. Sample locations for the Lower Camp Transformer Buildings (SS09) site are illustrated in Figure 4-6. All organic compounds detected are presented on the figure except when they were a result of laboratory contamination or field decontamination procedures. The exceptions are presented on the data summary table. The following section presents a discussion of organic compounds detected at the site.

Organics. Organic compounds detected in soil samples collected at the site include DRPH, RRPH, and PCBs. DRPH were detected in four samples ranging from 760 to 30,000 mg/kg. RRPH were detected in five samples ranging from 230 to 13,000 mg/kg. Aroclor 1254 and 1260 were detected in ten samples ranging from 0.1 to 5,600 mg/kg.

Inorganics. Metals were not a concern at the site, and no metals analyses were performed.

4.5.2.3 Summary of Site Contamination. The suspected source of the PCBs, Aroclors 1254 and 1260, detected during sampling conducted at the Lower Camp Transformer Buildings (SS09) is spills and/or leaks from the transformers that were previously located at the site. The affected soils samples were collected adjacent to the concrete pads on which the transformers were located. The area affected with PCBs appears to be localized. No previous sampling had been conducted at the site. Based on field data, source of contamination and concentration of contaminants, the areas affected cover approximately 183 square feet of the soil and gravel adjacent to the concrete pads in both buildings. The human health and ecological risks associated with the chemicals detected at the site are presented in Section 4.5.4. and 4.5.5.

4.5.3 Migration Pathways

This section describes the topography and stratigraphy of the site and the migration potential of contaminants from the site. A discussion of receptors and chemical concentrations at receptors is included.

4.5.3.1 Topography and Stratigraphy. The Lower Camp Transformer Buildings (SS09) site consists of two abandoned buildings. The buildings are located on level ground at the base of a small gravel slope located on the west side of the buildings. The general drainage at the site is towards the north.

During the RI, the active layer was approximately six feet thick in gravel areas similar to gravel at this site. Gravel fill and roads consisted of the typical gravels and sands associated with these features, and subsurface tundra materials were of the typical stratigraphy found at Cape Lisburne (Section 2.4.4.2).

4.5.3.2 Migration Potential.

Subsurface Migration. Topography indicates that any subsurface flow that does occur is towards the northwest. Because the topography is generally flat there is only a slight gradient to drive the flow of active layer water. Because the flux of water through the affected areas is limited (there is no direct precipitation in the buildings), and PCBs are relatively insoluble and were detected only in the shallow samples near the concrete pads, the potential for subsurface migration is minimal.

Surface Migration. There are no distinct surface drainage features in the immediate vicinity of the site, and there is no precipitation inside the building. Because of the lack of surface runoff and the relative insolubility of PCBs, the potential for surface migration is minimal.

Air Transport. Air transportation is not considered to be a significant mode of migration at the site (Section 2.4.4.5).

Summary of Migration Potential. The occurrence of PCBs at the site is limited and confined to the gravel pad areas within the buildings. Because PCBs are relatively insoluble and tend to bind to soil particles, the potential for transport is minimal.

4.5.3.3 Receptors and Chemical Concentrations at Receptors.

Human Receptors. Potential human receptors at the Lower Camp Transformer Buildings (SS09) site include Air Force contractor personnel working at the station, visitors to the station. Human receptors could potentially be exposed to the chemicals detected in soils/sediments at the site. The primary routes of potential exposures at the site are direct contact with soils/sediments and incidental ingestion of soils/sediments. Surface water was not considered a route of exposure because no surface waters are associated with the site. Because groundwater and air at the Cape Lisburne sites are not considered complete pathways of exposure, these media are not evaluated as potential pathways to human receptors.

The Cape Lisburne Risk Assessment (U.S. Air Force 1996) evaluates in detail the risks to human health from all COCs detected at the site. The potential receptor groups were selected based on their likelihood of exposure to contaminants at the site, and include radar installation workers, and native adults and children who may visit the site. The estimated exposure point concentrations for human receptors are based on the maximum concentration of each chemical detected at the site. The potential risks to human health associated with site chemicals at Cape Lisburne are presented in Section 4.6.4.

Ecological Receptors. Ecological receptors were evaluated in detail in the Cape Lisburne Risk Assessment (U.S. Air Force 1996) to determine if plants and animals could potentially be impacted by the chemicals detected at the Cape Lisburne installation. Because of the diversity of the plants and animals in the area of the Cape Lisburne installation, a set of representative species were selected in the ERA for detailed evaluation. The species include plants, aquatic invertebrates, fish, birds, and mammals. These receptors were selected based primarily on their likelihood of exposure given their preferred habitat and feeding habits. The representative species encompass a range of ecological niches in order the achieve the best characterization of the ecosystems being examined and are presented in Table 2-6.

The estimate of chemical concentrations at the ecological receptors was based on the average site-wide concentration of each COC. This approach was appropriate because few of the representative species would inhabit only one distinct site at the installation; they are more likely to be exposed to the mix of chemicals and concentrations of chemicals detected on all the sites at Cape Lisburne. The potential ecological risks associated with the site chemicals at Cape Lisburne are presented in Section 4.5.5.

4.5.4 Human Health Risk Assessment

This section presents a summary of the potential human health risks associated with the chemicals detected at the Lower Camp Transformer Buildings (SS09) site. The purpose of the human health risk assessment is to quantify the excess lifetime cancer risk and/or the noncancer hazard (reported as hazard index) for the contaminants detected at the site.

This summary presents the COCs at the site, the pathways by which human receptors may be exposed to site chemicals, potential risks to human health posed by each chemical through each exposure pathway evaluated, the significance of the risk and/or hazard estimate, and a

comparison of site chemical concentrations to ARARs. The methods and assumptions used in calculating hazards and risks are presented in Section 2.4.1.

4.5.4.1 Chemicals of Concern. At the Lower Camp Transformer Buildings (SS09), COCs identified in the soil/sediment at the site included DRPH, RRPH, and PCBs (Aroclor 1254 and 1260). DRPH and RRPH were selected as COCs because the maximum concentrations detected exceeded ARARs. PCBs (Aroclor 1254 and 1260) were selected as a COC because the maximum concentration detected exceeded the RBSL and ARAR. There were no surface water bodies associated with the site, and no surface water samples were collected.

Table 4-12, Identification of COCs at the Lower Camp Transformer Buildings (SS09), presents the maximum concentrations of chemicals detected at the site and associated background concentrations, RBSLs, and ARARs, and identifies COCs selected in the risk evaluation.

4.5.4.2 Exposure Pathways and Potential Receptors. Ingestion of soil/sediment was determined to be a potential exposure pathway at the site. Because no surface water is associated with the site, no evaluation of risk or hazard was conducted for water ingestion.

Three potential receptor groups were evaluated in the risk assessment: an adult assigned to a radar installation (worker), an adult inhabitant of the North Slope of Alaska (native), and a child living in a North Slope community (child).

4.5.4.3 Risk Characterization.

Noncancer Hazard and Cancer Risk Associated with Soils and Sediments. The noncancer hazard associated with the ingestion of soil at the Lower Camp Transformer Buildings (SS09) site by a hypothetical native northern adult/child is 445, and by a radar installation worker is 22, based on the maximum concentrations of the COCs. The presence of PCBs (Aroclor 1254 and 1260) accounts for 99 percent the quantifiable noncancer hazard for these receptor/pathway combinations. The excess lifetime cancer risk associated with the ingestion of soil at the site by the hypothetical native northern adult/child is 1×10^{-2}, and by a radar installation worker is 5×10^{-4}, based on the maximum concentrations of the COCs. The presence of PCBs (Aroclor 1254 and 1260) accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Noncancer Hazard and Cancer Risk Associated with Surface Water. No surface water bodies were identified at the Lower Camp Transformer Buildings (SS09). Therefore, there is no apparent surface water pathway, and no evaluation of noncancer hazard or excess lifetime cancer risk associated with ingestion of surface water at the site was conducted.

4.5.4.4 Summary of Human Health Risk Assessment. The potential risks and hazards associated with the soil/sediment at the Lower Camp Transformer Buildings (SS09) are the noncancer hazards associated with PCBs (hazard indices of 445 and 22) and cancer risks associated with the PCBs detected at the site. Although the hazards and risks were calculated conservatively based on maximum concentrations detected and using a residential scenario, the noncancer hazards and carcinogenic risks are above regulatory threshold values. Therefore, the

noncancer hazards and carcinogenic risks associated with soil at the site could potentially pose a threat to human health under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). Remedial action is generally warranted at sites where the excess lifetime cancer risk is $>1 \times 10^{-4}$ or the noncancer hazard significantly exceeds one (EPA 1991b). In conclusion, on the basis of cancer risk and noncancer hazard, remediation of the site is recommended.

4.5.5 Ecological Risk Assessment

The objective of the ERA is to estimate the potential impacts of chemicals detected at the installation to aquatic and terrestrial plants and animals. A summary of the methods used to assess potential ecological impacts is presented in Section 2.4.2.

4.5.5.1 Chemicals of Concern. COCs were selected based on criteria presented in Section 3.1 of the ERA. The average installation-wide concentrations of COCs were used to calculate the risk estimates. All sites at the installation were considered to be potentially usable habitat. It should be noted that the COC selection process only considered the soil/sediment samples that were at 1.5 feet deep or less. The soil/sediment samples were screened for depth because it is unlikely that any of the representative species will be exposed to soils/sediments deeper than 1.5 feet. Of the chemicals detected in soils/sediments (surface water was not sampled) at the Lower Camp Transformer Buildings, DRPH, RRPH, Aroclor 1254, and Aroclor 1260 were identified as COCs. Aroclor 1254 and Aroclor 1260 are associated with elevated risk estimates for ecological receptors.

4.5.5.2 Exposure Pathways and Potential Receptors. Potential exposure pathways for terrestrial organisms include direct contact with, and ingestion of, contaminated soil/sediment. The most significant route of exposure for plants is direct contact with soil. Receptors may also be exposed to COCs through ingestion of plant and animal items in their diet, and incidental ingestion of soil/sediment while foraging, although these pathways are considered less significant and are not used to calculate HQs. Birds and mammals may be exposed to COCs through ingestion of surface water, ingestion of plant and animal diet items (although only ingestion of plant matter was quantified in the estimated exposure equation), and incidental ingestion of soil/sediment.

The potential ecological receptors evaluated in the risk assessment include plants, aquatic organisms, and birds, and mammals likely to occur along the Arctic Coastal Plain. Representative species from these receptor groups were selected based primarily on the species' likelihood of exposure, preferred habitat and feeding habits. Species that may be particularly sensitive to environmental impacts, such as threatened and endangered species, are considered on an individual basis if present at or near the installation. No sensitive species were identified (Alaska Biological Research 1994) or evaluated at the Cape Lisburne. The species evaluated in the ERA are listed in Table 2-6.

4.5.5.3 Risk Characterization. Potential risks at the Lower Camp Transformer Buildings are related to elevated HQs for Aroclor 1254 and Aroclor 1260. Specifically, the HQs for Aroclor 1254 are 1.8 for the brant, 7 for the pectoral sandpiper, and 7 for the brown lemming. The HQs for Aroclor 1260 are 2.4 for the glaucous gull, 7 for the Lapland longspur, 17 for the brant, 69 for

the pectoral sandpiper, and 69 for the brown lemming. HQs for the remaining COCs are below 1.0 for the other representative species.

4.5.5.4 Summary of Ecological Risk Assessment. No aquatic species were evaluated at the site because no surface water data were available. The PCB concentrations at the Lower Camp Transformer Buildings contribute significantly to the elevated HQs for Aroclor 1254 and Aroclor 1260. The risk estimates for Aroclor 1254 and Aroclor 1260 are based on the toxicity of Aroclor 1254, which has been shown to be slightly more toxic. As a result the risk estimates are grouped low to moderate for the glaucous gull, Lapland longspur, brant, pectoral sandpiper, and brown lemming. In addition, the future risks associated with PCBs may be greater than current estimates because of the high potential for PCB bioaccumulation in the food chain.

4.5.6 Conclusions and Recommendations

Sampling and analyses have determined that the Lower Camp Transformer Buildings (SS09) site is contaminated DRPH, RRPH, and PCBs (Aroclors 1254 and 1260).

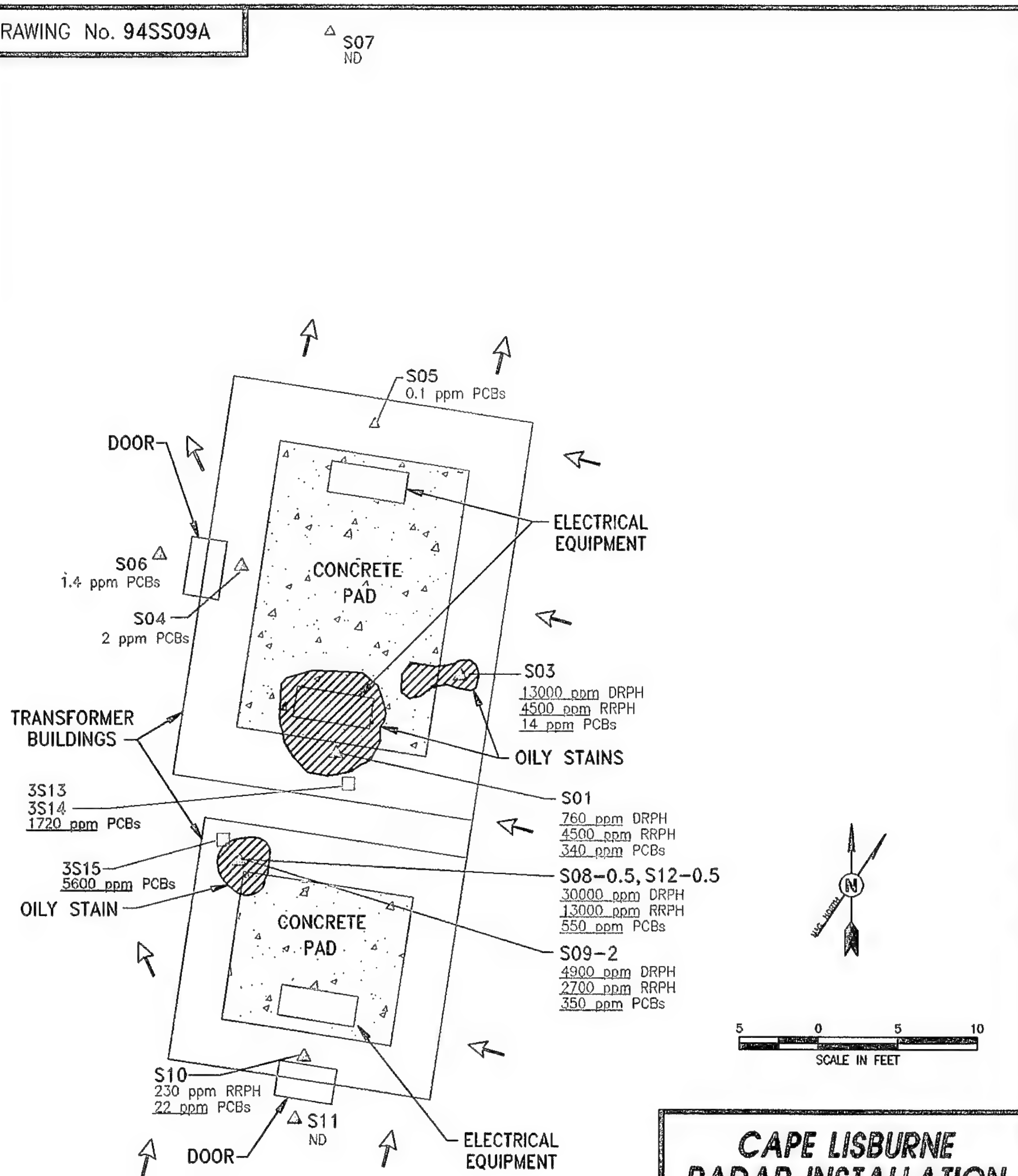
The contaminated areas at the site are the soil and gravel areas adjacent to the concrete pads on which the transformers were previously located. The likely source of contamination is former spills and/or leaks of transformer fluid. The transformers and equipment were removed from the buildings when the site was deactivated.

Migration of contaminants from the site appears to have been minimal. Contaminated gravel is limited to approximately 183 square feet adjacent to the concrete transformer pads. The potential for migration of contaminants is not anticipated as the site is relatively flat, PCBs are relatively insoluble and tend to bind tightly with soil particles, and the area is enclosed by buildings where there is minimal surface or subsurface migration.

The risk assessment concluded that risks to human health and ecological receptors from site contaminants could pose a threat under the conditions assumed in the Risk Assessment (U.S. Air Force 1996). The potential human health risks at the site are of a magnitude that normally requires remedial action (i.e., cancer risk is $>1 \times 10^{-4}$ and noncancer hazard is significantly >1). Therefore, considering the findings of the risk assessment, remediation of the site is recommended.

In addition, levels of PCBs detected in gravel at the site exceed regulatory cleanup levels and can potentially bioaccumulate in the environment. Therefore, the site is being recommended for remedial action. The contaminated area at the site consists of approximately 20 cubic yards of soil and gravel. The remedial action alternative recommended for the site is offsite treatment/disposal. A complete description and evaluation of the remedial alternatives considered for this site are presented in the Feasibility Study, Section 5.0

DRAWING No. 94SS09A



CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 4-6
LOWER CAMP TRANSFORMER BUILDINGS (SS09)
SAMPLE LOCATIONS AND ANALYTICAL RESULTS

LEGEND

▭	BUILDINGS, STRUCTURES
□	94 SOIL SAMPLE
△	SOIL SAMPLE
→	SURFACE DRAINAGE
0.9 ppm	F&B DATA
1500 ppm	9/94 CTE DATA

0000	CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND	NO CONTAMINATION DETECTED
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
RRPH	RESIDUAL RANGE PETROLEUM HYDROCARBONS
PEST	PESTICIDES
PCBs	POLYCHLORINATED BIPHENYLS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 4-11. LOWER CAMP TRANSFORMER BUILDINGS ANALYTICAL DATA SUMMARY

Installation: Cape Lisburne
Site: Lower Camp Transformer Buildings (SS09)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples S01	S03	S04	S05	S06	S07	Field Blank EB01	Lab Blanks	
Laboratory Sample ID Numbers					1383	1384	1385	1386	1387	1388	1558 1561	#6-9393 #1&2-9493	#6-9293 #6-9593
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	<60[b]-<150[b]	760J[b]	13,000J[b]	<50[b]	<50[b]	<50J[b]	<50[b]	<1,000J[b]	<2,000	<50
RRPH (Approx.)	10	100	2,000[a]	<120-<300	4,500	4,500	<100	<100	<100	<100	<2,000	<4,000	<100
Pesticides													
Endosulfan 1	0.001	0.01	4	<0.01J	NA	NA	NA	NA	0.03R	NA	<0.2J	<0.2	<0.01
Endrin Aldehyde	0.001	0.01		<0.01J	NA	NA	NA	NA	0.02R	NA	<0.2J	<0.2	<0.01
Endosulfan Sulfate	0.001	0.01		<0.01J	NA	NA	NA	NA	0.02R	NA	<0.2J	<0.2	<0.01
PCBs													
Aroclor 1260	0.01-0.1	0.1-1	10	<0.02-20JN	340JN[d]	14JN[d]	2JN	0.1	1.4JN	<0.1	<2J	<10	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
R Result has been rejected.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d The laboratory reported the results were outside of the calibration range.

TABLE 4-11. LOWER CAMP TRANSFORMER BUILDINGS ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Lower Camp Transformer Buildings (SS09)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blank	Lab Blanks	
					S08 & S12 (Replicates)		S09-2	S10	S11	EB01		
Laboratory Sample ID Numbers					1389	1393	1390	1391	1392	1558/1561	#6-9393 #1&2-9493	#6-9293
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	<60[b]-<150[b]	30,000J[b]	25,000J[b]	4,900J[b]	<50J[b]	<50[b]	<1,000J[b]	<2,000	<50
RRPH (Approx.)	10	100	2,000[a]	<120-<300	12,000	13,000	2,700	230	<100	<2,000	<4,000	<100
PCBs												
Aroclor 1260	0.01-0.1	0.1-1	10	<0.02-20JN	380JN[d]	550JN[d]	350JN[d]	22JN	<0.1	<2J	<10	<0.1-<0.5

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d The laboratory reported the results were outside of the calibration range.

TABLE 4-11. LOWER CAMP TRANSFORMER BUILDINGS ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Cape Lisburne
Site: Lower Camp Transformer Buildings (SS09)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blank			Lab Blanks	
					3S13 &3S14 (Replicates)		3S15				3EB01				
Laboratory Sample ID Numbers					4608-3	4608-2	4608-1				4608-1			4608	4608
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				µg/L			µg/L	mg/kg
PCBs															
Aroclor 1254	0.020	0.020	10	<0.02-<0.3	1,010	1,720	<0.020				<1.00			<1.00	<0.03
Aroclor 1260	0.020	0.020	10	<0.02-<20JN	<0.020	<0.020	5,600				<1.00			<1.00	<0.03

□ CT&E Data.
▩ F&B Data.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

TABLE 4-12. IDENTIFICATION OF CHEMICALS OF CONCERN AT THE LOWER CAMP TRANSFORMER BUILDINGS (SS09)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Lower Camp Transformer Buildings (SS09)	Soil/Sediment	DRPH	30,000J	mg/kg	<60-<150	--	--	500[c]	**Yes**
		RRPH	13,000	mg/kg	<120-<300	--	--	2,000[c]	**Yes**
		Aroclor 1254	1,720	mg/kg	<0.02-<0.3	0.00831[d]	0.540	10[f]	**Yes**
		Aroclor 1260	5,600	mg/kg	<0.02-20JN	0.00831[d]	0.540[e]	10[f]	**Yes**

< Indicates Not Detected.
a Risk-Based Screening Level.
b Applicable or Relevant and Appropriate Requirement.
c ADEC 1991.
d Cancer RBSL for Aroclor 1254 and 1260 is based on the cancer slope factor for PCBs (IRIS 1995).
e Noncancer RBSL for Aroclor 1260 based on oral reference dose (RfD) for Aroclor 1254.
f TSCA cleanup level.
J Result is an estimate.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

5.0 FEASIBILITY STUDY

The purpose of this section is to present the FS of remedial alternatives for the sites at Cape Lisburne radar installation that are recommended for remedial action. These sites were identified based on the findings of the RI, reported in Sections 1.0 through 4.0 of this document, and the Cape Lisburne Risk Assessment (U.S. Air Force 1996). The Cape Lisburne sites recommended for remedial action and covered by this FS are:

- Landfill and Waste Accumulation Area (LF01);
- White Alice Site (SS03);
- Spill/Leak #3 (ST07);
- Upper Camp Transformer Building (SS08); and
- Lower Camp Transformer Buildings (SS09).

Complete RI results for these sites are presented in Section 4.0. This FS describes the evaluation of remedial alternatives used as the basis for the selection of the proposed remedial actions for the five sites presented in Section 4.0.

The area of concern (AOC) requiring no further action based on the RI and risk assessment are not included in this section. The proposed no further action AOC is the Water Gallery (AOC3). RI results for this AOC are presented in Section 3.0

This FS complies with the NCP. It has been streamlined as described in the following section. The remainder of the introduction consists of a discussion of the streamlining approach, including risk management decisions, and an outline of the organization of the FS.

5.0.1 Approach To Feasibility Study

Five sites have been recommended for remedial action at Cape Lisburne. Table 5-1 presents the estimated volumes of contaminated soil at each site. The volume estimates are derived from the RI, and, especially in the case of the Landfill and Waste Accumulation Area (LF01), the actual volumes requiring remediation may be more or less than the estimated volumes. This is because the nature and extent of contamination cannot be determined until the areas are excavated, the contents of drums sampled and analyzed, and the extent of soil contamination determined. Until buried metal objects are inspected, it cannot be determined whether the objects are drums or metal debris and if the drums contain waste liquids.

The approach for the FS is to use the same remedial alternatives for the Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). The Landfill and Waste Accumulation Area (LF01) is contaminated with spent solvents listed under 40 CFR 261.31 of RCRA, PCBs, DRPH, and GRPH. The RCRA land disposal restrictions require that media contaminated with listed spent solvents be treated to meet the Treatment Standards for Hazardous Wastes (40 CFR 268.40) prior to disposal. Several soil samples from the RI show that concentrations of carbon tetrachloride and trichloroethene exceed land disposal treatment standards for listed solvents

TABLE 5-1. VOLUMES OF CONTAMINATED SOIL AT THE FIVE SITES TARGETED FOR REMEDIAL ACTION AT CAPE LISBURNE

SITE	ESTIMATED AREA IN SQUARE FEET	ESTIMATED DEPTH IN FEET	ESTIMATED VOLUME IN CUBIC YARDS	PERCENT OF TOTAL ESTIMATED VOLUME
Landfill and Waste Accumulation Area (LF01)*	12,100	5	2,427	19%
White Alice Site (SS03)	2,800	3	311	2.4%
Upper Camp Transformer Building (SS08)	250	3	28	0.2%
Lower Camp Transformer Buildings (SS09)	183	3	20	0.2%
Spill/Leak #3 (ST07)	90,000	3	10,000	78.2%
TOTALS			12,786	100%

* The estimated area and volume of contaminated media at the Landfill and Waste Accumulation Area (LF01) include: Gravel Covered Area #1, 120' x 80'x 5' = 1,778 cubic yards; Gravel Covered Area #2, 100' x 25' x 5' = 463 cubic yards; and 186 cubic yards in containment cell.

under 40 CFR 261.31 (F-listed solvents). Currently, the only method of offsite treatment permitted for soils contaminated with F-listed solvents is incineration. Toxic Substances Control Act (TSCA) regulations require that nonliquid media with PCB contamination in excess of 50 mg/kg must be either treated by incineration or disposed in a chemical waste landfill (40 CFR 761.60). In addition, based on the concentrations of solvents and PCBs detected in the containment cell soils and drummed liquids during the IRA at the Landfill and Waste Accumulation Area and the probability of more buried drums, there is potential for percent-level concentrations of both solvents during remediation. The land disposal restrictions, therefore, limit the remedial options for the Landfill and Waste Accumulation Area (LF01), or 19 percent of the contamination at Cape Lisburne, to excavation and offsite treatment/disposal, or thermal desorption and offsite incineration of the condensate.

The White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) together comprise approximately 2.8 percent of the estimated volume of contamination at Cape Lisburne. The COCs at the three sites include PCBs, and petroleum hydrocarbons in the diesel and residual ranges. The concentrations of PCBs at these sites require offsite incineration or disposal, or thermal desorption with offsite incineration of the condensate.

The largest volume of contaminated soil is at Spill/Leak #3 (ST07), representing an estimated 78.2 percent of the volume of contamination at the installation. This site is located along a hillside below above-ground diesel fuel storage tanks. It is unlikely that this site will be excavated because diesel is the primary contaminant at the site, and it is not contaminated with PCBs or

F-listed solvents. In addition, the risk assessment determined that there are no human health or ecological risks associated with the site. Excavation may be technically infeasible due to the high probability of sloughing of the hillside and damage to the storage tanks.

The above discussion suggests that an extensive site-specific evaluation for four of the five sites at the Cape Lisburne installation is inappropriate because the soils must be excavated and incinerated or disposed according to the applicable regulations. Instead, two excavation and treatment/disposal options are evaluated for the combined contamination from the Landfill and Waste Accumulation Area (LF01), the White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). Spill/Leak #3 (ST07) is evaluated separately, with the focus on solutions that integrate the existing water collection and treatment system that was installed during IRAs at the site.

In addition, these streamlining steps have also been taken:

- Repetition of information presented in the RI (Section 1.0 through 4.0 of this report) and the Cape Lisburne Risk Assessment is minimized. Data essential to evaluating remedial alternatives are presented in summary tables.

- The summary table recommended in the AFCEE Handbook (U.S. Air Force 1991a) has been adapted to focus on the data essential to the evaluation of remedial alternatives. Wherever possible, reference is made to the RI and risk assessment for detailed site information, and assumptions used in calculating risk and identifying COCs.

- Alternatives evaluated are limited to those likely to be effective.

- General response actions (GRAs) and applicable technologies are screened together, and the alternatives are limited to no more than five successfully applied conventional and innovative methods including the required no action alternative.

5.0.2 Risk Management Decisions

Based on a thorough review of the data, a risk management decision relating to surface water was made in the FS in order to focus the results of the RI/FS and risk assessment into workable and protective remedial alternatives.

Surface water in tundra areas has been impacted by sources of contamination at the installation. Methods for remediating surface water directly are not promising because it is extremely shallow, covers a wide area, is frozen for over half the year, and is intimately associated with tundra. The first three factors are technically challenging and the fourth is perhaps most limiting. ADEC recognizes that physical methods of remediating tundra are often more harmful than petroleum hydrocarbon contamination (Interim Guidance for Non-UST Contaminated Soil Cleanup Levels, Guidance Number 001 - Revision Number 1, July 17, 1991, Page 10). Instead of evaluating direct remedial alternatives for surface water in otherwise natural tundra areas, we have taken the approach that remediation of the source will improve the quality of surface water over time.

This risk management decision permits the focus of the FS to be cleaning up the sources of contamination at the Cape Lisburne installation. The contaminated areas at the Landfill and Waste Accumulation Area (LF01) site will be excavated and the wastes treated or disposed offsite. Surface water quality will improve as these source areas are removed. In addition, the water collection and treatment system at Spill/Leak #3 (ST07) currently prevents contaminant migration from the site.

5.0.3 Organization

The FS is organized as follows:

- Introduction;
- Site characterization for remediation (considers COCs, ranges of chemicals detected, estimated areas and volumes of affected media, ARARs, and target cleanup levels or proposed remediation goals for each site);
- Screening of GRAs and presentation of representative remedial technologies;
- Development of remedial alternatives;
- Detailed evaluation of remedial alternatives (the detailed analysis is based on the AFCEE guidance and includes analyses of the nine NCP criteria). The detailed evaluation also includes a comparative analysis of alternatives, and identification of preferred alternatives);
- Siting study; and
- Detailed cost estimates and estimates of project duration in attachments A and B, respectively.

5.1 SITE CHARACTERIZATION FOR REMEDIATION

Information relevant to the screening and evaluation of remedial alternatives for the four combined sites and Spill/Leak #3 (ST07) at Cape Lisburne is summarized in Tables 5-2 and 5-3. The tables include COCs in site soils, ranges of chemicals detected, estimates of volumes of affected media, and the basis for listing each as a COC.

5.1.1 Summary of Site Information

The information considered for each site includes:

- medium;
- COCs;
- range of chemicals detected;

TABLE 5-2. REMEDIAL ACTION CHARACTERIZATION FOR THE COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

MEDIA	CONTAMINANTS*	RANGE OF ENVIRONMENTAL CONTAMINATION	TARGET CLEANUP LEVEL	BASIS FOR LISTING AS COC	VOLUME OF CONTAMINATED MEDIA	DESIGN PARAMETERS
Tundra, soil, sediment, drums, debris, gravel, and concrete pads	DRPH	ND - 51,000[b] mg/kg	500 mg/kg[a]	ADEC Non-UST Action Level	2,786 cubic yards	• Depth of contamination • Depth of permafrost • Amount of debris • Number of buried drums containing free liquids, solvents, or PCBs • Weather
	RRPH	ND - 43,100[c] mg/kg	2,000 mg/kg[a]	ADEC Non-UST Action Level		
	Aroclor 1254	ND - 1,720[d] mg/kg	<10 mg/kg[g]	Risk $>10^{-6}$/Ecological Risk		
	Aroclor 1260	ND - 6,290[e] mg/kg	<10 mg/kg[g]	Risk $>10^{-6}$/Ecological Risk		
	Carbon tetrachloride	ND - 17.3[f] mg/kg	4.92 mg/kg[h]	Risk $>10^{-6}$		

* The contaminants listed do not include the highly contaminated soils stored within the containment cell. The maximum concentrations of the primary contaminants in these soils is as follows: diesel range organics 118,000 mg/kg, residual range organics 174,000 mg/kg, carbon tetrachloride 3,510 mg/kg, and trichloroethene 900 mg/kg.

a Target cleanup levels based on ADEC Non UST guidance do not necessarily correspond to final site specific cleanup goals.

b From Upper Camp Transformer Building (SS08). Maximum concentrations over cleanup levels at other sites are: 18,600 mg/kg (LF01); 30,000 mg/kg (SS09).

c From Landfill and Waste Accumulation Area. Maximum concentrations over cleanup levels at other sites are: 29,000 mg/kg (SS08); 13,000 mg/kg (SS09).

d From Lower Camp Transformer Buildings (SS09). Maximum concentrations over cleanup levels at other sites are: 29.1 mg/kg (SS08).

e From White Alice Site (SS03). Maximum concentrations over cleanup levels at other sites are: 300 mg/kg (SS08); 5,600 mg/kg (SS09).

f From Landfill and Waste Accumulation Area (LF01).

g TSCA cleanup levels.

h Based on risk level of 1×10^{-6}, does not necessarily correspond to final site specific cleanup goals.

TABLE 5-3. REMEDIAL ACTION CHARACTERIZATION FOR SPILL/LEAK #3 (ST07)

MEDIA	CONTAMINANTS	RANGE OF ENVIRONMENTAL CONTAMINATION	TARGET CLEANUP LEVEL[a]	BASIS FOR LISTING AS COC	VOLUME OF CONTAMINATED MEDIA	DESIGN PARAMETERS
Soil/Gravel	DRPH	ND - 63,000 mg/kg	500 mg/kg	ADEC Non UST Action Level	10,000 cubic yards	• microbial activity • soil moisture • nutrient levels • soil pH
	GRPH	ND - 150 mg/kg	100 mg/kg	ADEC Non UST Action Level		
	Benzene	ND - 1.4 mg/kg	0.5 mg/kg	ADEC Non UST Action Level		

[a] Target cleanup levels for DRPH, GRPH, and benzene in soil are based on ADEC Non UST guidance and do not necessarily correspond to final site specific cleanup goals.

- target cleanup level (or proposed remediation goal - the lowest applicable action level, based on the risk assessment including cancer risk, noncancer hazard quotient, and chemical-specific ARARs);
- basis for the target cleanup level (chemical-specific ARAR, cancer risk or noncancer hazard quotient); and
- design parameters for remedial action.

5.1.2 Estimated Areas, Volumes, and Masses of Contaminated Media

The approximate areas, volumes, and mass of the contaminated media are presented in Table 5-4. Areas and depths are estimated based on the RI, and the density is estimated to be 1.8 tons/cubic yard. Actual areas and depth of contamination may differ from the estimates, which will affect the cost of remediation. The locations and estimated volumes of contaminated media are illustrated in Figure 5-1. The media include soil, gravel, tundra, drums, and debris at the Landfill and Waste Accumulation Area (LF01), gravel at the White Alice Site (SS03), gravel and stained concrete pads inside the transformer building sites (SS08 and SS09), and soil and gravel at Spill/Leak #3 (ST07). Total volumes are:

- Combined sites (LF01, SS03, SS08, and SS09) - approximately 2,786 cubic yards of soil, drums, debris, tundra, gravel, and concrete pad.

- Spill/Leak #3 (ST07) - approximately 10,000 cubic yards of soil and gravel.

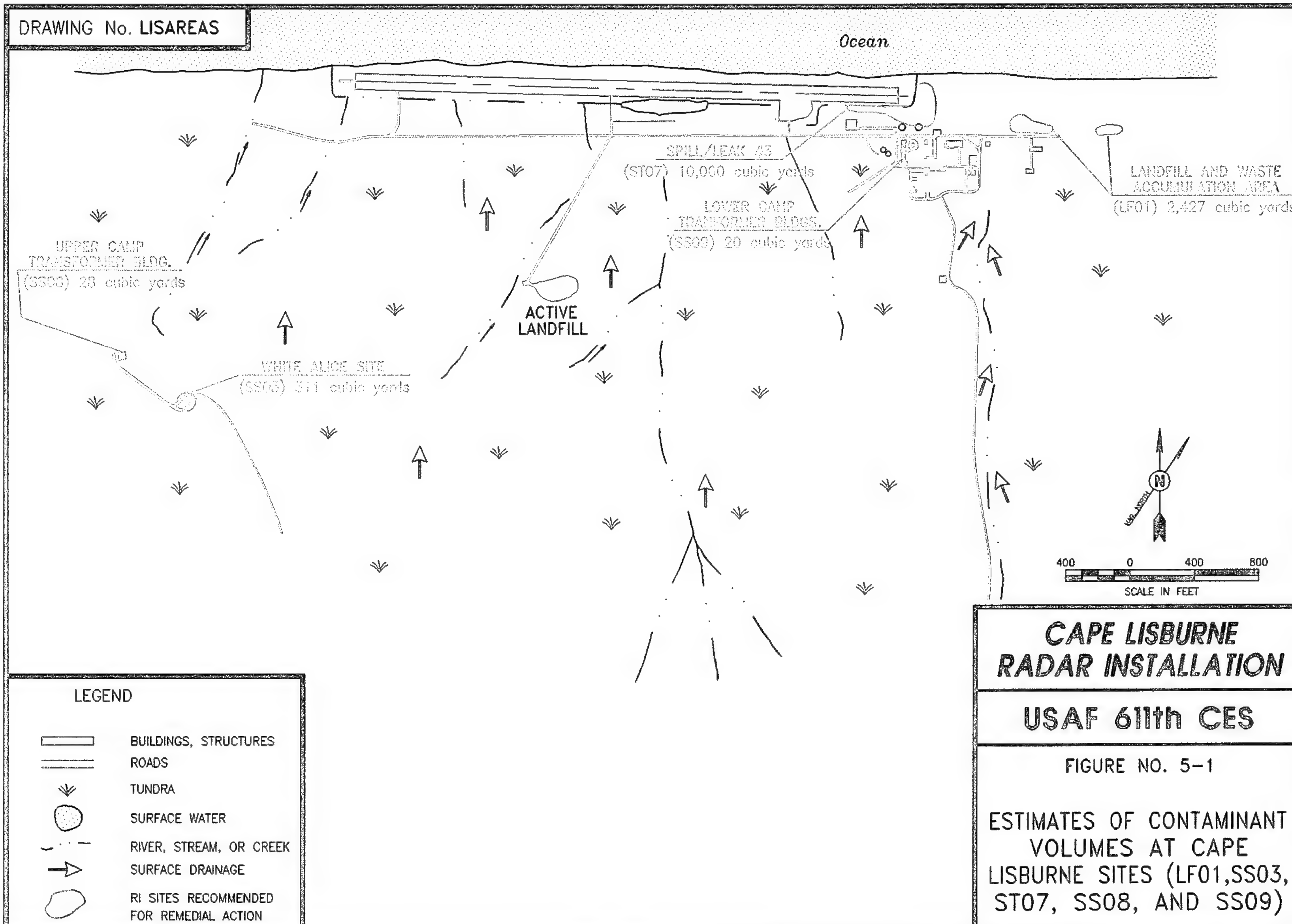
GRAs and remedial alternatives are screened and evaluated for these sites. Estimates of cost and project duration are provided in Attachments A and B, respectively. These attachments are located at the end of Section 5.0.

TABLE 5-4. APPROXIMATE AREAS, VOLUMES AND MASSES OF CONTAMINATED MEDIA BY SITE AT CAPE LISBURNE

SITE	MEDIUM	AREA (sq ft)	DEPTH (ft)	VOLUME (cy)	MASS (tons)
Landfill and Waste Accumulation Area (LF01)	soil/drums/debris/ tundra/gravel	12,100	5	2,427	4,370
White Alice Site (SS03)	gravel	2,800	3	311	560
Upper Camp Transformer Building (SS08)	gravel/concrete pad	250	3	28	50
Lower Camp Transformer Buildings (SS09)	gravel/concrete pad	183	3	20	37
Spill/Leak #3 (ST07)	soil/gravel	90,000	3	10,000	18,000

THIS PAGE INTENTIONALLY LEFT BLANK

DRAWING No. LISAREAS



CAPE LISBURNE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 5-1

ESTIMATES OF CONTAMINANT VOLUMES AT CAPE LISBURNE SITES (LF01,SS03, ST07, SS08, AND SS09)

THIS PAGE INTENTIONALLY LEFT BLANK

5.1.3 ARARs

According to the NCP, ARARs must be identified and evaluated to determine all the requirements for remedial actions. There are three categories of ARARs:

- Chemical-specific;
- Action-specific; and
- Location-specific.

Chemical-specific ARARs are action levels that may apply in addition to risk or hazard-based remediation goals. Chemical-specific ARARs were identified during the RI and included in the risk assessment. The target cleanup levels or proposed remediation goals represent the lowest applicable action level.

Action-specific ARARs are requirements that relate to how remedial actions must be conducted. For example, offsite transport of hazardous waste must be manifested in compliance with RCRA.

Location-specific ARARs impose requirements on a remedial action based on the location of the site. For example, there are specific requirements that pertain to wetlands.

It should be noted that ADEC's Interim Guidance for Non UST contaminated soil target cleanup levels is intended as guidance and does not necessarily correspond to final site-specific cleanup levels. The ARARs for the sites at the Cape Lisburne installation are presented in Table 5-5.

5.2 SCREENING OF GENERAL RESPONSE ACTIONS

5.2.1 Presentation and Screening of General Response Actions

GRAs are general approaches for remedial actions. GRAs can be active or passive measures. Active measures involve removal, active treatment, or isolation of the contaminated media. Passive measures rely on natural processes to reduce the toxicity, mobility or volume of contamination, or on controls put in place to limit exposure. GRAs apply to contaminants in all of the environmental media separately, or in any combination. Screening GRAs streamlines the FS process by establishing the feasibility of entire classes of remedial responses, thereby enabling the selection of a focused set of viable alternatives for detailed evaluation. GRAs have been evaluated for the combined sites LF01, SS03, SS08, and SS09; and for Spill/Leak #3 (ST07).

The criteria for screening GRAs are implementability, duration, effectiveness, and cost. Implementability is estimated in terms of technical and administrative barriers. For example, containment is generally less acceptable to regulatory agencies than removal or treatment. An innovative technology that has proven to be effective in the continental U.S. may not be implementable on the North Slope due to harsh environment or because it cannot be transported there.

TABLE 5-5. ARARS FOR SITES AT THE CAPE LISBURNE INSTALLATION

AUTHORITY	CITATION	TYPE OF ARAR	BASIS	CATEGORY OF ARAR
Clean Air Act	42 U.S.C. 7401-7642, 40 CFR 60, 61, and 63	Action-specific	National Ambient Air Quality Standards (Treatment technology standards for fugitive emissions and landfills)	Applicable
ADEC, Interim Guidance for Non-UST Action Levels	18 AAC 75.140	Chemical-specific	Standards for general guidance	Relevant and Appropriate
RCRA	40 CFR Part 263	Action-specific	Standards Applicable to Generators of Hazardous Waste	Relevant and Appropriate
RCRA	40 CFR 268	Action-specific	Land Disposal Restrictions	Relevant and Appropriate
ADEC, Interim Guidance for Surface and Groundwater Cleanup Levels	AS 46.03.070, AS 46.09.020, 18 AAC 70.020 (b), AS 46.04.020, 18 AAC 75.140, 18 AAC 70.025, 18 AAC 70.030 18 AAC 70.010, and 18 AAC 70.040	Location-specific	Standards applicable for water used for drinking and surface water important to the growth and propagation of aquatic life	Relevant and Appropriate
Toxic Substances Control Act	40 CFR 761.60(a)(4)	Action-specific	Disposal Requirements	Applicable
ADEC, Interim Guidance for Surface and Groundwater Cleanup Levels	AS 46.03.070 AS 46.09.020 AS 46.04.020 18 AAC 70.020 18 AAC 75.140	Chemical-specific	Standards applicable for water used for drinking and surface water important to the growth and propagation of aquatic life	Relevant and Appropriate
SDWA	52 FR 25690 56 FR 3526	Chemical-specific	Maximum Contaminant Level for drinking water	Relevant and Appropriate
RCRA	55 FR 30798	Chemical-specific	Standard for Solid Waste Management Units, SWMUs, in the RCRA Corrective Action Program	Relevant and Appropriate

Duration is the estimate of the time necessary to attain the projected treatment efficiency. Treatment efficiency is estimated from applicable case studies and the literature. The estimated duration of no action that includes natural biodegradation is long even through the time necessary to implement no action is short.

Effectiveness is the relative success of the response action in reducing contamination and risk to acceptable levels.

Cost is the estimated capital, operating, and administrative costs necessary to attain the projected treatment efficiency. This estimate is presented in relative terms (low, medium, and high).

The GRAs considered for the Cape Lisburne installation are:

- No Action;
- Institutional Controls and Monitoring;
- Containment;
- Onsite Treatment; and
- Removal.

These GRAs are defined as follows.

No Action. Under the no action GRA contaminants are left in place and only natural processes, such as biodegradation, would lower the concentrations of COCs.

Institutional Controls and Monitoring. The institutional control GRA is a passive response in which steps are taken to minimize the possibility of accidental exposure of humans and the environment to COCs. Institutional controls may include fences to minimize exposure and public education. Institutional control of sites contaminated by petroleum hydrocarbons minimizes the chances of accidental exposure while passive biodegradation occurs. Monitoring is included to determine if migration of contaminants is occurring and if natural processes are lowering the concentrations of the COC.

Containment. The containment GRA limits the potential for accidental exposure to contaminants by physical means. Examples include soil caps and solidification. The objectives are: 1) to minimize the risk of direct exposure to contaminated soils; 2) to eliminate the possibility of contaminants or contaminated soils becoming airborne and migrating; and 3) to prevent water from entering the contaminated area and transporting contaminants to other areas.

Onsite Treatment. Treatment may be used to reduce the toxicity, mobility, or volume of a contaminant and may be accomplished in situ or ex situ. In situ treatment involves active treatment with the medium in place. Ex situ treatment involves the removal of the contaminated medium, with subsequent treatment on the installation. The medium may be replaced in the original excavation after treatment. Treatment efficiencies vary depending on the technique used and the type of contaminant present. These efficiencies, presented in Section 5.4., normally are 85 to 95 percent.

Removal. Removal involves excavating the contaminated medium and shipping it offsite for treatment or disposal. Removal reduces the risk of exposure to the contaminant, because it no longer remains at the installation. There is some risk to remedial workers undertaking such a removal.

The applicability of these GRAs at Cape Lisburne was determined using AFCEE screening criteria: implementability, project duration, effectiveness, and cost benefit. Representative technologies for the GRAs retained are presented and screened in Section 5.2.2. Screening was performed as follows.

5.2.1.1 Screening of GRAs for Source Area at the Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). GRAs considered for remediation at the combined four sites are presented in Table 5-6. No action, onsite treatment, and removal were retained for evaluation.

5.2.1.2 Screening of GRAs for Spill/Leak #3 (ST07). GRAs considered for remediation of the soils and tundra along the hillside are presented in Table 5-7. No action, institutional controls and monitoring, and onsite treatment were retained for evaluation.

5.2.2 Presentation of Technologies

This section describes remedial technologies considered for use at Cape Lisburne. GRAs retained in Section 5.2.1 that represent successfully applied technologies in the Alaskan environment were selected. The conditions present at the Cape Lisburne installation, principally the arctic climate and remote location, exclude many technologies that could be considered for sites in a more temperate and accessible location.

The remedial technologies under consideration for the contaminated media at the Cape Lisburne installation are presented in this section as follows:

<u>No Action</u>

- No action

<u>Institutional Controls and Monitoring</u>

- Monitoring
- Public education
- Fencing

TABLE 5-6. SCREENING OF GENERAL RESPONSE ACTIONS FOR REMEDIATION OF THE COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

GENERAL RESPONSE ACTION	REPRESENTATIVE TECHNOLOGIES	PROJECTED TREATMENT EFFICIENCY	RETAINED OR REJECTED	RATIONALE
No action	• No action	5 percent	Retained	Implementability: Low Duration: Short Effectiveness: Low Cost: Low Retained/Rejected: Retained as required by the National Contingency Plan.
Institutional controls and monitoring	• Annual monitoring • Public education • Fencing	5 percent	Rejected	Implementability: Low Duration: Moderate Effectiveness: Low Cost: Low Retained/Rejected: Rejected due to low implementability and low effectiveness.
Containment	• Solidification • Capping	25 percent reduction in mobility	Rejected	Implementability: Low Duration: Long Effectiveness: Low Cost: High Retained/Rejected: Rejected due to low implementability, low effectiveness, and long duration.
Onsite Treatment	• Onsite thermal desorption and offsite incineration of desorbed liquids	100 percent	Retained	Implementability: High Duration: Moderate to Long Effectiveness: High Cost: Moderate to High Retained/Rejected: Retained due to high implementability (land disposal restrictions require incineration of condensate) and high effectiveness.
Removal	• Offsite treatment/ disposal of soils and liquids	100 percent	Retained	Implementability: Moderate Duration: Short to Moderate Effectiveness: High Cost: Moderate to High Retained/Rejected: Retained due to moderate implementability, high effectiveness, and short to moderate duration.

TABLE 5-7. SCREENING OF GENERAL RESPONSE ACTIONS FOR REMEDIATION OF SPILL/LEAK #3 (ST07)

GENERAL RESPONSE ACTION	REPRESENTATIVE TECHNOLOGIES	PROJECTED TREATMENT EFFICIENCY	RETAINED OR REJECTED	RATIONALE
No action	• No action	50 percent	Retained	Implementability: Moderate Duration: Short Effectiveness: Moderate Cost: Low Retained/Rejected: Retained (requirement of NCP).
Institutional controls and monitoring	• Annual monitoring • Public education • Fencing	50 percent	Retained	Implementability: High Duration: Moderate Effectiveness: Moderate Cost: Low Retained/Rejected: Retained due to high implementability, moderate effectiveness and low cost.
Containment	• Barrier walls	80 percent reduction in mobility	Rejected	Implementability: Moderate Duration: Long Effectiveness: Moderate Cost: High Retained/Rejected: Rejected due to moderate implementability, moderate effectiveness, and high cost.
Onsite treatment	• Enhanced bioremediation	94 percent	Retained	Implementability: Moderate Duration: Long Effectiveness: Moderate to High Cost: Moderate Retained/Rejected: Retained due to moderate implementability and moderate to high effectiveness.
Removal	• Offsite treatment or disposal	100 percent	Rejected	Implementability: Low (seepage and slope instability are major problems) Duration: Short Effectiveness: High Cost: High Retained/Rejected: Rejected due to low implementability and high cost.

Treatment

Onsite:

- Thermal desorption
- Enhanced bioremediation

Removal

- Offsite treatment/disposal

All of the technologies presented above have been applied effectively at sites on the North Slope or elsewhere in Alaska. In addition to being effective in cold climates, they are well-suited to the short summer season, the only favorable time for outdoor remedial activities, and the remote location where there is little or no manpower for year-round operation and maintenance of remedial systems. Specifically, these remedial technologies are either short-term actions that can be completed in one season (approximately 100 days) with imported labor, or longer term actions that are self-sustaining and require minimal labor.

Several of the remedial technologies involve bioremediation, which can be accomplished on the North Slope with psychrophilic (i.e., cold weather) microorganisms and fungi, both indigenous and imported.

Bioremediation has been documented on the North Slope and elsewhere in Alaska, but is subject to several limiting factors including:

- availability of nutrients and oxygen;
- short periods of thaw; and
- percentage of finer grained materials.

Biodegradation can generally be estimated in terms of first order kinetics where the only rate limiting factor is the biodegradation potential, a function of the factors listed above. With first order kinetics a given target cleanup level will eventually be reached regardless of the initial concentration. As the gap between initial and target concentrations widens, however, or rate limiting factors become more significant, the time necessary to reach the target increases exponentially because the function plots asymptotically with concentration. A more detailed discussion of the estimates of biodegradation is presented in Section 5.4

Descriptions of the selected technologies are presented in the following subsections.

5.2.2.1 No Action. Required alternative.

5.2.2.2 Institutional Controls and Monitoring. This technology involves no active treatment, rather it takes advantage of unassisted biodegradation that occurs in arctic soil (Atlas 1985). Natural bioremediation typically takes longer than assisted in situ bioremediation. The rate of biodegradation, especially in the North Slope region, is reduced because of short warm

seasons and prolonged harsh winters. Public education and fencing off the affected area would constitute institutional controls, and monitoring would include sampling and analysis of any associated surface water and soil/sediment.

Institutional controls and monitoring are being evaluated for petroleum-related contaminants in gravel and soil areas. The case studies used to support biodegradation-based alternatives were used to estimate rates of bioremediation.

5.2.2.3 Thermal Desorption. This technology involves moderate temperature treatment (200-500°F) of the contaminated media. Contaminants are not destroyed, but are instead vaporized, condensed, and collected. Condensed material that is prohibited from land disposal under 40 CFR 268 must be treated by Best Demonstrated Available Technology (BDAT), which, in the case of the contaminant constituents, is incineration. Thermal desorption may be conducted onsite. Condensed liquids that are restricted from land disposal must be sent offsite for incineration at a RCRA permitted facility. There may be difficulties in treating bulky materials, such as drums and debris; therefore, those must be segregated before treatment. Figure 5-2 is the process flow of excavation, thermal desorption, and offsite incineration.

5.2.2.4 Enhanced Bioremediation. Enhanced bioremediation in this FS involves delivering water and nutrients to the contaminated soils in place to assist natural bioremediation. Several organisms that can utilize the carbon in petroleum are indigenous to the North Slope, including: *Bacillus cereus, Bacillus polymixa, Arthrobacter globiformics* and *Alcaligenes poradoxus* (Ratliff 1993). In addition, several strains of *Pseudomonas* bacteria (psychrophilic genera) decreased TPH concentration in tundra during the summer season in the Prudhoe Bay area (Jorgenson et al. 1992). A case study conducted at Point Thompson, Alaska, suggests that this approach is feasible for remediation of gravel pads if a cultured population of microbes is used (Liddell 1991). The cultured population could be either indigenous or exotic. A treatability study will be necessary to determine how best to bioremediate soil.

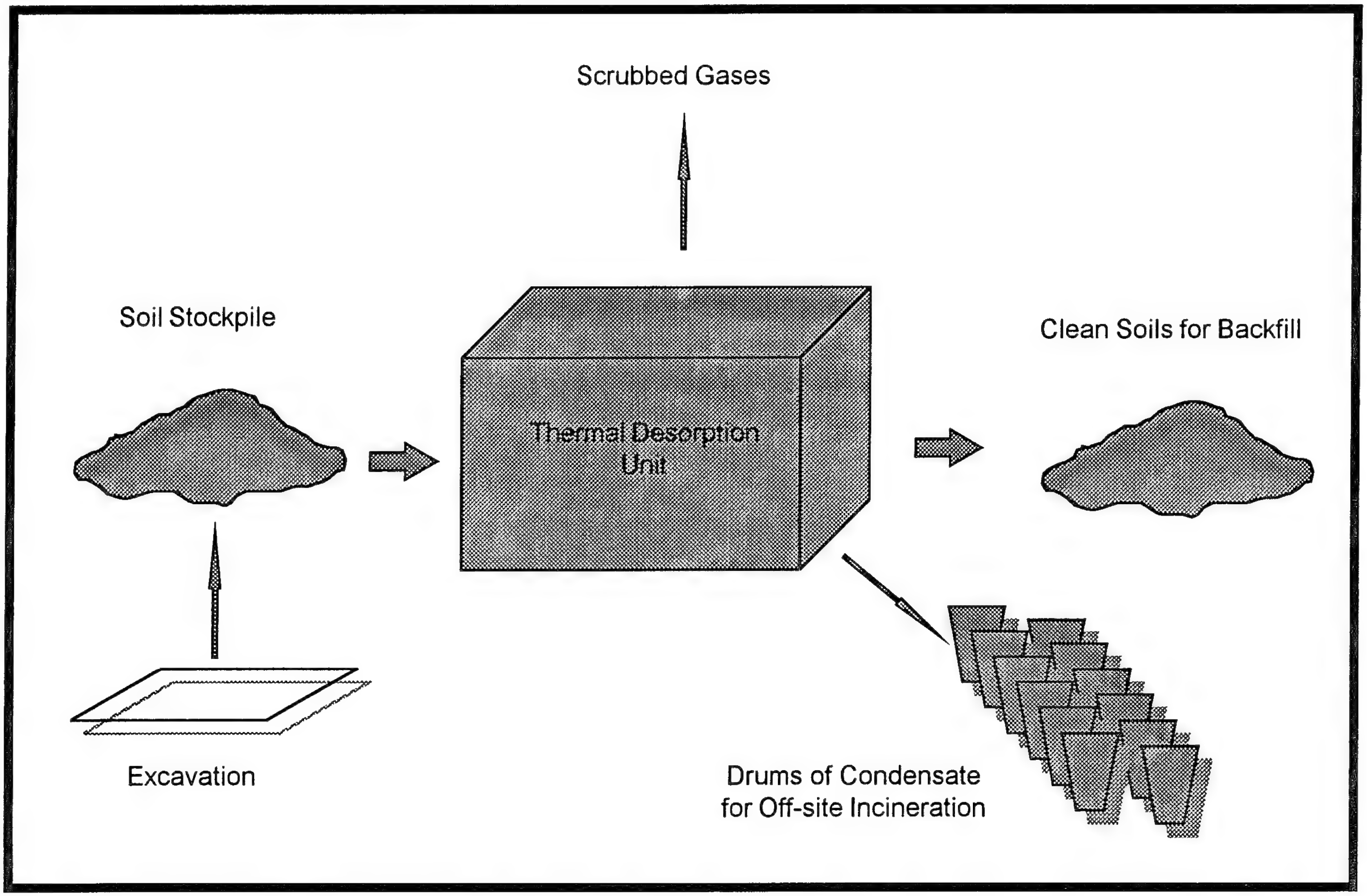
Variations in temperature affect the rate of biodegradation by bacteria. In the arctic environment, bacteria remain active enough to consume petroleum hydrocarbon molecules from June through August when average temperatures fluctuate between 33.8 and 42.8°F (Atlas 1985). Successful biodegradation of petroleum hydrocarbon contaminants in soil by indigenous bacteria is possible at the arctic summer ambient temperatures (Jacobson et al. 1982). Another study at Surfcote Pad in the Prudhoe Bay area (Evans, Elder, and Hoffman 1992) indicates that native microbial populations were capable of bioremediating diesel contaminated gravel at an appreciable rate during the short summer season. In the arctic environment at a depth of three feet microbial populations can effectively consume hydrocarbon products (Atlas 1985); however, the number and activity of bacteria decrease with depth because of lower temperatures and reduced levels of oxygen and nutrients.

Monitoring for two years will verify the progress of the process.

Enhanced bioremediation is being evaluated for the soil and gravel along the hillside at Spill/Leak #3 (ST07). Water and nutrients would be added intermittently based on the results of a

4-4 STET

Figure ~~5-2~~: Thermal Desorption and Off-Site Incineration Process Flow Diagram



THIS PAGE INTENTIONALLY LEFT BLANK

treatability study. This process may generate runoff but the existing french drain/treatment system should capture it. Figure 5-3 is a schematic of enhanced bioremediation.

5.2.2.5 Offsite Treatment/Disposal. This method includes the excavation and removal of all soil, drums, debris, tundra, gravel, and concrete pads where contaminant concentrations exceed cleanup levels. The media is segregated by type and extent of contamination, then packaged for shipment and transported to one or more offsite Treatment, Storage or Disposal Facilities (TSDFs) for treatment and/or disposal.

The land disposal restrictions require that F-listed solvents meet treatment standards (40 CFR 268.40) prior to disposal. Currently, the only permitted offsite treatment method for F-listed solvents is incineration. Additionally, media contaminated with PCBs at concentrations greater than 50 mg/kg must be either incinerated or disposed in an approved chemical waste landfill (40 CFR 761.60). Offsite land disposal may also be utilized for non-RCRA wastes such as soil and gravel contaminated with DRPH and GRPH.

Offsite treatment/disposal is being evaluated for the PCB and solvent-contaminated media at the combined sites. Incineration is the selected offsite treatment method for media contaminated with F-listed solvents at the Landfill and Waste Accumulation Area (LF01), and direct land disposal is selected for all nonliquid PCB and TPH contaminated media from the combined sites (LF01, SS03, SS08, and SS09).

5.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

5.3.1 Approach to Developing Remedial Alternatives

The remedial technologies selected in Section 5.2.2 represent the GRAs retained in Section 5.2.1. In this section remedial technologies are developed into alternatives designed to address site-specific COCs. Alternatives developed in this section will be evaluated in the Detailed Evaluation of Remedial Alternatives in Section 5.4 and evaluated with respect to the NCP's nine criteria in Section 5.4.5.

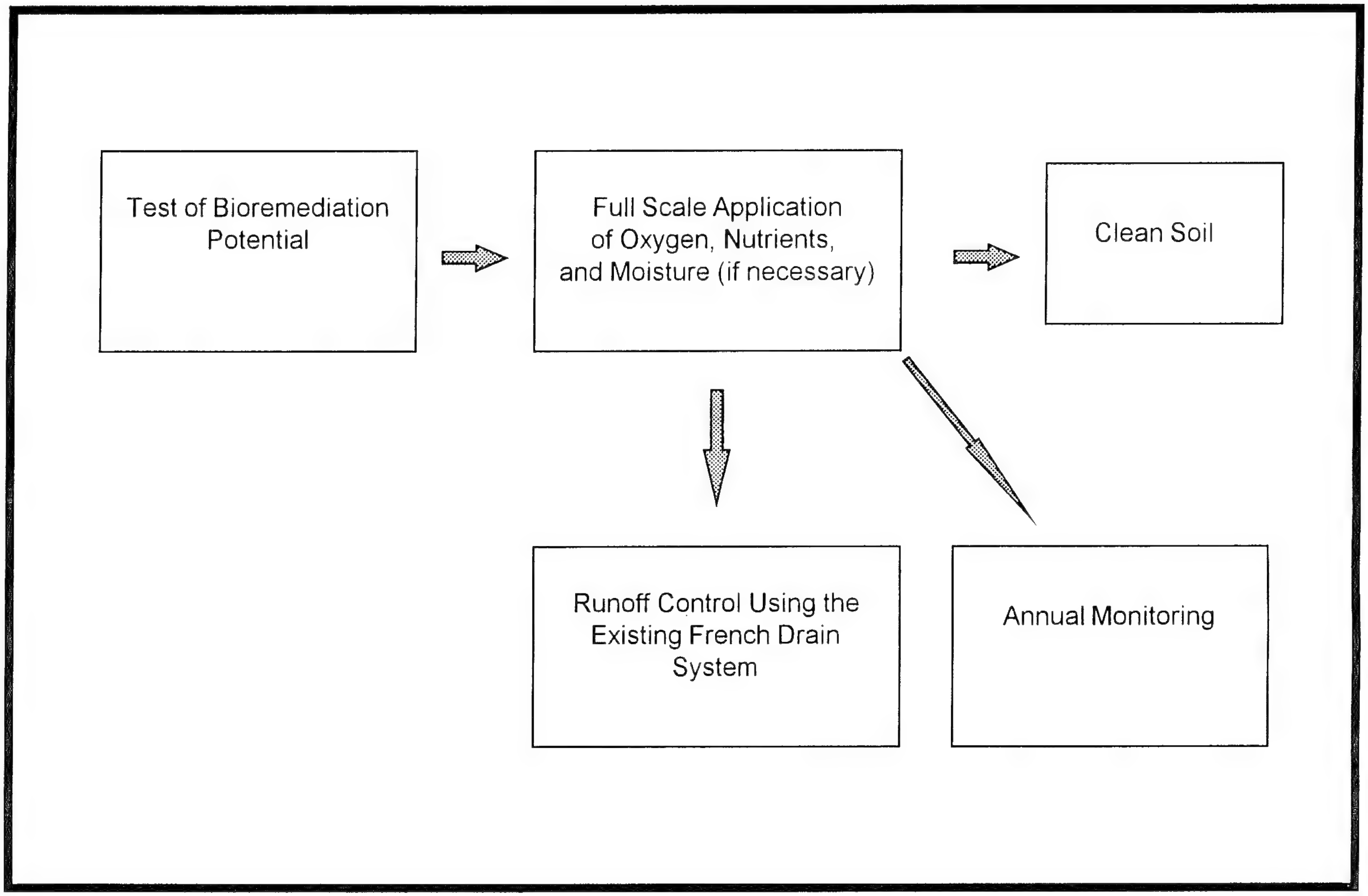
This section is organized by remedial alternative, and the rationale for development and a list of applicable sites and media are included. At the end of the section is a summary table of remedial alternatives by media and site. The technologies are described in Section 5.2 and are not discussed further in this section.

5.3.1.1 No Action.

Rationale for Development. No action provides a baseline against which other alternatives are compared. It is a required alternative according to the NCP. Natural attenuation of petroleum hydrocarbons may occur through biodegradation if microbial populations and aerobic conditions (e.g., water, oxygen, temperature, and nutrients) are present.

THIS PAGE INTENTIONALLY LEFT BLANK

Figure 5-3: Enhanced Bioremediation Process Flow Diagram



THIS PAGE INTENTIONALLY LEFT BLANK

Applicable Media and Sites.

- Soil, drums, debris, tundra, gravel, and concrete pads: combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09).

- Soil and gravel: Spill/Leak #3 (ST07).

5.3.1.2 Institutional Controls and Monitoring.

Rationale for Development. This limited action alternative is applicable to Spill/Leak #3 (ST07) because the COCs do not pose a risk or HQ above threshold levels (10^{-6} for risk and 1 for HQ). Natural attenuation of petroleum hydrocarbons may occur through biodegradation if microbial populations and aerobic conditions (e.g., water, oxygen, temperature, and nutrients) are present.

Institutional controls considered include public education fencing off the affected area and continued operation and maintenance of the onsite water collection and treatment system. Monitoring will document the progress of remediation.

Applicable Media and Sites.

- Soil and gravel: Spill/Leak #3 (ST07)

5.3.1.3 Enhanced Bioremediation

Rationale for Development. This is a low maintenance method for reducing petroleum concentrations in tundra that is also applicable to gravel. Enhanced bioremediation in this FS is assisted (i.e., enhanced natural bioremediation). The assistance is low level, and includes the addition of appropriate amounts of nutrients, lime, and moisture, and the assumption that sufficient oxygen is present to support aerobic metabolism of hydrocarbons. This alternative is more aggressive than natural, unassisted attenuation, yet can be designed to limit disturbance of the tundra and permafrost. A treatability study will be necessary to demonstrate site-specific viability of this alternative. For example, the percentage of fine-grained soils in the gravel will affect its ability to retain moisture and organic carbon.

Monitoring will verify the progress of the process.

Applicable Media and Site.

- Soil and gravel: Spill/Leak #3 (ST07)

5.3.1.4 Thermal Desorption

Rationale for Development. This alternative will significantly reduce the amount of material to be incinerated. Mobile thermal desorption units can be mobilized to the Cape Lisburne installation. Thermally desorbed soil could be reintroduced to excavation areas. This alternative

includes offsite incineration of the condensate from the thermal desorption process at a TSDF permitted to treat wastes such as F-listed solvents and PCBs.

Applicable Media and Site.

- Soil, drums, debris, gravel, and concrete pads: combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09).

5.3.1.5 Offsite Treatment/Disposal

Rationale for Development. Offsite treatment or disposal is an established method for treating solvent contaminated media and disposing of PCB-contaminated media. Treatment, in this case, would be incineration; disposal is the placement of nonliquid PCB wastes into a chemical waste landfill. Either incineration or land disposal is required by TSCA for PCB contaminated media with concentrations of greater than 50 mg/kg (40 CFR 761.60). Additionally, incineration is the BDAT for treatment of F-listed solvent wastes, such as carbon tetrachloride and trichloroethene detected at significant levels in the contained soils at the Landfill and Waste Accumulation Area (LF01). Site contaminant reduction exceeds 99 percent because all contaminated media is removed and transported offsite.

Applicable Media and Sites.

- Soil, drums, debris, gravel, and concrete pads: combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09).

5.4 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

5.4.1 Approach

The alternatives developed in Section 5.3 are evaluated in this section using the suggested criteria in the AFCEE Guidance for remedial alternative evaluation. These five criteria are defined in Sections 5.4.1.1 through 5.4.1.5. The detailed evaluation of alternatives is presented in Section 5.4.2 for the combined sites (LF01, SS03, SS08, and SS09) and in Section 5.4.3 for Spill/Leak #3 (ST07). The detailed evaluation of alternatives is summarized in Section 5.4.4. The alternatives are evaluated with respect to the NCP's nine criteria in Section 5.4.5. Preferred alternatives are presented in Section 5.4.6.

5.4.1.1 Successful Application Of The Technology Under Site Conditions. This criterion requires the location and approximate date of the applications, the managing entity, and a presentation of successful applications of the given alternative under conditions similar to those found at the Cape Lisburne installation. Case studies conducted on the Alaskan North Slope are used to the extent possible.

5.4.1.2 Total Project Cost. The total cost of performing the remedial alternative is estimated and divided into technology testing, capital, total labor, operating, environmental testing, closure, and indirect costs.

For the purpose of this evaluation, the itemized cost elements are defined as follows:

- Technology testing costs consist of pilot tests or treatability studies;
- Capital costs include equipment or materials purchased;
- Total labor costs include the labor required for operating and maintaining the remedial action system, oversight, project management, design, and development of planning documents;
- Operating costs include costs other than labor associated with operating remedial systems (e.g., thermal desorption system) and earth moving;
- Environmental testing costs are for sampling and analysis, including monitoring;
- Closure costs are for reporting site closure.

5.4.1.3 Contaminant Reduction. The reduction in concentration of each COC may be projected for each site based on case-study derived efficiencies. This reduction, referred to as post-remedial concentration, is listed with the initial concentration and target cleanup level. Post-remedial concentration is a more useful measure of the effectiveness than risk reduction for the remedial alternatives at the Cape Lisburne installation because some of the COCs are included because they exceed ARARs rather than having elevated cancer risk or noncancer hazard quotient. Risks or HQs, therefore, are not always indicators of successful remediation.

The concentrations presented in Section 5.4.4 (Tables 5-14 through 5-15) are defined as follows:

Initial Concentration. This is the maximum concentration of the COC detected.

Target Cleanup Level. This is the cleanup level specified for the given COC (the basis for which is presented in Tables 5-2 and 5-3).

Post Remedial Concentration. This is the estimated final concentration of the COC based on remedial efficiencies from case studies. References to these case studies can be found in Sections 5.4.2.1 and 5.4.3.1, Successful Applications of Alternatives. Estimated remedial efficiencies presented apply to all organic COCs for thermal desorption and offsite treatment/disposal. For enhanced bioremediation, the estimated remedial efficiencies are based on DRPH, GRPH, and benzene. Specific estimated efficiencies are presented below. The estimates are independent of time (over the short term, e.g., one year, enhanced biodegradation would be significantly less efficient than active remedial alternatives).

The following efficiencies are used for all organic compounds detected at the combined sites (LF01, SS03, SS08, and SS09):

- No action or institutional controls and monitoring - 5 percent (Unassisted bioremediation)
- Thermal desorption - 100 percent
- Offsite treatment/disposal- 100 percent

The following efficiencies are used for DRPH, GRPH, and benzene at Spill/Leak #3 (ST07):

- No action or institutional controls and monitoring - 50 percent (Unassisted bioremediation)
- Enhanced bioremediation - 94 percent

The post-remedial concentration is estimated using the following formula assuming no time constraints:

Post-remedial Concentration = Initial Concentration x (1 - Remedial Efficiency)

5.4.1.4 Project Duration. The estimated duration of each of the remedial alternatives and associated project schedules is an important consideration because of the seasonal limitations on outdoor work and the lack of personnel to perform operation and maintenance activities in this remote location. The North Slope of Alaska is frozen and covered with snow and ice for the majority of the year, leaving a period of only approximately 100 days in the summer when the weather is favorable for outdoor work, especially remedial alternatives involving excavation and flowing water. Outdoor phases of remedial actions significantly longer than 100 days must be suspended until the following summer, causing a marked increase in duration because of the extended winter down time. In order to maximize efficiency, remedial alternatives are designed to either complete outdoor phases of remediation within this narrow time frame (e.g., excavation and offsite incineration), or extend over a longer term and require only minimal labor (e.g., institutional controls and monitoring, enhanced bioremediation).

Project durations are based on case studies from Alaska. The rates of biological degradation for enhanced bioremediation, and naturally occurring bioremediation associated with institutional controls and monitoring are expressed as a decay function. The first-order decay function used to model this biological degradation is $C = C_o e^{-kt}$ (C is final concentration, C_o is the initial concentration, e is the natural logarithm, k is a constant based on case studies, and t is time).

The rate constant, k, is estimated based on related case studies. In general, the k-values presented reflect the lower end of the expected range of values and are downwardly adjusted because of the arctic environment conditions. The lowest rates are associated with no action and institutional controls and monitoring because there is no enhancement of conditions. DRPH is used to estimate the constants for all of the petroleum hydrocarbons because it represents by far the highest concentrations at the site where bioremediation is considered. The concentration of DRPH, therefore, is the controlling factor in determining the effectiveness of the remedial alternatives. The following constants and criteria were used for estimation of remedial rates:

DRPH Reduction

Institutional Controls and Monitoring (Unassisted bioremediation)	k = 0.0025/day

The k-value for no action and institutional controls and monitoring is based on rate data from a control cell in an experiment to measure the effectiveness of enhanced bioremediation (Liddell 1991). The case study k-value was decreased in an attempt to reduce the bias that aeration of the control cell introduces.

Enhanced bioremediation	k = 0.008/day

This rate is based on the rates found from observing a number of case studies. It represents the low end of the range of decay constants observed because many of the case studies took place under temperate climatic conditions.

A comparison of the predicted degradation of DRPH using the two bioremedial technologies being evaluated is illustrated in Figure 5-4.

The duration of onsite remedial activity and the total project duration are presented in Attachment B. These durations are defined as follows:

- Duration of onsite remedial activity includes all onsite activities related to conducting the remedial action: sampling, operating remedial equipment, time required for biodegradation, and mobilization and demobilization (this is a quantification of the relative duration estimates in Tables 5-6 and 5-7); and

- Total project duration includes the duration of onsite remedial activity, as well as time required for preparing planning documents, conducting permitting activities, and closure. For bioremediation alternatives, closures are planned within three years of the start of activities. Three years provide enough time either for the COCs to biodegrade to target cleanup levels or demonstrate a clear trend in that direction.

5.4.1.5 Data Gaps. Data gaps include any environmental testing or treatability studies that must be done to determine the effectiveness of a given remedial alternative under site conditions.

Table 5-8 summarizes the remedial alternatives evaluated in Sections 5.4.2 and 5.4.3 for the combined sites (LF01, SS03, SS08, and SS09) and the Spill/Leak #3 (ST07), respectively.

TABLE 5-8. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED

MEDIA	SITES	REMEDIAL ALTERNATIVES
Soil, tundra, drums, debris, gravel, and concrete pads	Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09)	No action Thermal desorption Offsite treatment/disposal
Soil and gravel	Spill/Leak #3 (ST07)	No action Institutional controls and monitoring Enhanced bioremediation

5.4.2 Detailed Evaluation of Alternatives for Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09)

This section presents a detailed evaluation of remedial alternatives for the Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09).

Alternatives considered for treatment of the source areas at the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) are:

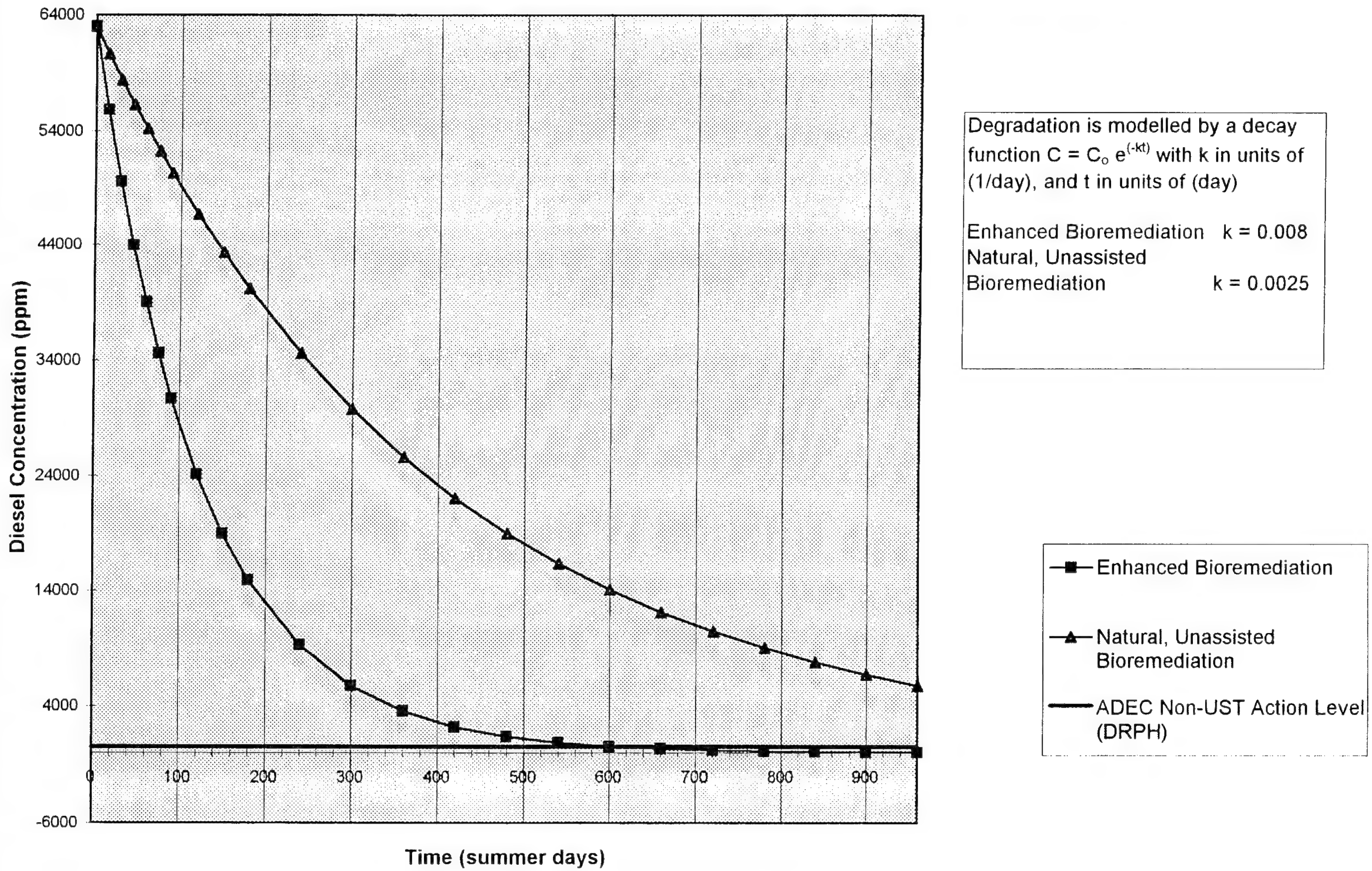
- No action;
- Thermal desorption; and
- Offsite treatment/disposal.

5.4.2.1 Successful Applications of Alternatives.

No Action. This alternative cannot be successful because of the presence of contaminants that, by regulation, must be excavated and treated or disposed offsite. Even without the regulatory mandate, the contaminants; PCBs, F-listed solvents, and high concentrations of petroleum hydrocarbons; are apt to serve as an ongoing source of contamination to tundra and surface water because the degradation potential for some of the contaminants (PCBs) is very low.

Thermal Desorption. Thermal desorption is an established method for removing organics from soils. Mobile units exist with the capability of removing petroleum hydrocarbons, F-listed solvents, and polyaromatic chlorinated organics like PCBs. One unit successfully reduced gasoline and oil concentrations in 800 tons of soil from 25,000 ppm to less than 20 ppm (PEMCO 1993). The reported performance of one mobile unit on PCBs is a reduction in concentration from 960 mg/kg to <1 mg/kg in a pilot study. It may be necessary to use a screened hopper to separate out debris-laden soil because most mobile units use a screw-auger type conveyor.

Figure 5-4. Comparative Biodegradation of Diesel Fuel in Soils (Basis: Maximum Diesel Concentration of 63,000 ppm at Spill/Leak #3)



THIS PAGE INTENTIONALLY LEFT BLANK

Offsite Treatment/Disposal. This is an established method for treating solvent contaminated media and disposing of PCB-contaminated media. Treatment, in this case, would be incineration; disposal is the placement of nonliquid PCB wastes into a chemical waste landfill. Either incineration or land disposal is required by TSCA for PCB-contaminated media with concentrations of greater than 50 mg/kg (40 CFR 761.60). Incineration is also BDAT for treatment of RCRA spent solvent wastes, such as carbon tetrachloride and trichloroethene, that were detected at the Landfill and Waste Accumulation Area (LF01). Site contaminant reduction exceeds 99 percent because all contaminated media is removed and transported offsite.

5.4.2.2 Project Costs. Table 5-9 is a summary of project costs for the remedial alternatives being considered for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09). Detailed cost estimates for each remedial alternative are presented in Attachment A.

5.4.2.3 Contaminant Reduction.

No Action. No action at the sites will probably result in natural bioremediation of some site contaminants. Contaminants such as PCBs bioremediate very slowly, and the no action alternative would provide little contaminant reduction for these compounds.

Thermal Desorption. Source removal will involve removal of all soil, tundra, drums, debris, gravel, and concrete pads in the areas contaminated above the target cleanup levels, therefore there will be a 100 percent reduction in any COCs (above cleanup levels) present at these sites. As a result of this projection, no table of contaminant reduction is necessary or included.

Offsite Treatment/Disposal. The 100 percent contaminant reduction noted above also applies to this remedial alternative.

5.4.2.4 Project Duration. A breakdown of the project durations for the remedial alternatives being considered for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) is shown in Table 5-10. Detailed project duration tables for each of the alternatives considered for remediating the source areas at the Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) are located in Attachment B.

5.4.2.5 Data Gaps.

No Action. The data gap is the biodegration potential at the sites.

Thermal Desorption. Technology testing will be necessary to ensure that thermal desorption can remove the contaminants. High concentrations of chlorinated organics and petroleum hydrocarbons can pose a problem. An alternative treatment, solvent extraction, also has limitations. Fine-grained soils do not wash well. There are innovative techniques that could be explored if necessary, including a dry solvent wash developed at the University of Alaska at

TABLE 5-9. SUMMARY OF PROJECT COSTS FOR REMEDIAL ALTERNATIVES EVALUATED FOR THE COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

REMEDIAL ALTERNATIVE	TECHNOLOGY TESTING	CAPITAL COST	TOTAL LABOR	OPERATING COST	ENVIRONMENTAL TESTING	CLOSURE COST	ADMINISTRATIVE AND OTHER INDIRECT COSTS	PRESENT VALUE
No action	$0	$0	$0	$0	$0	$7,500	$1,875	$9,375
Thermal desorption	$15,000	$91,965	$3,538,270	$4,543,250	$4,000	$10,000	$3,340,995	$11,692,479
Offsite treatment/disposal	$0	$19,270	$291,935	$6,634,950	$4,000	$10,000	$2,974,282	$10,395,990

TABLE 5-10. ESTIMATED PROJECT DURATION FOR REMEDIAL ALTERNATIVES CONSIDERED FOR THE COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

REMEDIAL ALTERNATIVE	DURATION OF ONSITE REMEDIAL ACTIVITY (Days)	TOTAL PROJECT DURATION (Days)
No action	0	30
Thermal desorption	1,348	1,468
Offsite treatment/disposal	115	235

Fairbanks. It may be that only part of the volume of contaminated media can be treated to concentrate the COCs, in which case the volume that cannot be treated would be packaged for transport and offsite treatment/disposal. The cost of this hybrid would be somewhere between the estimates for thermal desorption/treatment/disposal and offsite treatment/disposal. The data gap listed for offsite treatment/disposal below also applies to the alternative.

Offsite Treatment/Disposal. The data gap is the lack of knowledge on the type and degree of contamination in the source areas (i.e., number and contents of buried drums and volume of contaminated soil).

5.4.3 Detailed Evaluation of Alternatives for Spill/Leak #3 (ST07)

This section presents a detailed evaluation of remedial alternatives for Spill/Leak #3 (ST07) site. Alternatives considered for treatment of Spill/Leak #3 (ST07) are:

- No action;
- Institutional controls and monitoring; and
- Enhanced bioremediation.

5.4.3.1 Successful Applications of Alternatives.

No Action. As part of a study on in situ bioremediation of DRPH-contaminated gravel pads and soils near Prudhoe Bay, a control cell was left unassisted and untreated. This control cell was, in essence, natural attenuation. Initial DRPH concentration was approximately 1,900 mg/kg. After nine weeks the DRPH concentration had decreased to 1,200 mg/kg. This indicates a reduction of 37 percent in DRPH concentration in 63 days. In addition, a slight increase in the microbial population was noted (Liddell et al. 1991).

Institutional Controls and Monitoring. The bioremediation study noted above applies to this remedial alternative.

Enhanced Bioremediation. Enhanced bioremediation (i.e., through nutrient, lime, and moisture addition) has been successfully implemented in the arctic environment to treat petroleum hydrocarbon contamination on the North Slope. Studies at Point Thompson and Kuparuk oil fields in Alaska show that enhanced bioremediation is a successful and efficient method for remediating and reducing the concentration of petroleum hydrocarbons to a desired level within a relatively short time. The Point Thompson case study shows that 16,000 cubic yards of TPH contaminated gravel with an initial concentration of 2,000 to 3,000 ppm was bioremediated to an average concentration of 285 ppm between July and September 1990 (Liddel et al 1991).

The estimated remedial action efficiency of enhanced bioremediation is 94 percent based on case studies done in Alaska and estimates of biodegradation kinetics.

5.4.3.2 Project Costs. A summary of project costs is included in Table 5-11. Detailed cost estimates for each remedial alternative are located in Attachment A.

5.4.3.3 Contaminant Reduction. The degree to which concentrations of COCs will meet target cleanup levels (proposed remediation goals) for each alternative is summarized in Table 5-12.

5.4.3.4 Project Duration. Estimated project durations are summarized in Table 5-13. Alternatives considered for the site depend on biodegradation; the rate of biodegradation is the primary factor leading to the long project durations. Detailed project duration estimates for each of the alternatives are located in Attachment B.

5.4.3.5 Data Gaps.

No Action. There are no data gaps.

Institutional Controls and Monitoring. The data gap is the lack of information on biodegradation potential.

Enhanced Bioremediation. The lack of information on biodegradation potential of soil and gravel areas is the data gap. A treatability study is necessary to determine the biodegradation potential of contaminants in the soil and gravel along the hillside, and to determine the type and amount of nutrient additions to enhance biodegradation.

5.4.4 Summary of Detailed Evaluation of Remedial Alternatives

Tables 5-14 and 5-15 summarize the remedial alternatives evaluated for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09); and Spill/Leak #3 (ST07). Costs presented in the tables are based on the unit costs developed for each remedial alternative and the estimated volumes of contaminated media.

TABLE 5-11. SUMMARY OF PROJECT COSTS FOR REMEDIAL ALTERNATIVES EVALUATED FOR THE SPILL/LEAK #3 (ST07)

REMEDIAL ALTERNATIVE	TECHNOLOGY TESTING	CAPITAL COST	TOTAL LABOR	OPERATING COST	ENVIRONMENTAL TESTING	CLOSURE COST	ADMINISTRATIVE AND OTHER INDIRECT COSTS	PRESENT VALUE
No action	$0	$0	$0	$0	$0	$7,500	$1,875	$9,375
Institutional controls and monitoring	$0	$100	$42,200	$20,175	$520	$5,000	$18,350	$86,345
Enhanced bioremediation	$7,500	$6,510	$74,505	$40,875	$775	$4,319	$34,475	$168,960

TABLE 5-12. ESTIMATED CONTAMINANT REDUCTION AT SPILL/LEAK #3 (ST07)

REMEDIAL ACTION	CONTAMINANTS	INITIAL CONCENTRATION (mg/kg)	TARGET CLEANUP LEVEL (mg/kg)	POST REMEDIAL CONCENTRATION (mg/kg)
No action	DRPH	63,000	500	31,500
	GRPH	150	100	75
	Benzene	1.4	0.5	0.7
Institutional controls and monitoring	DRPH	63,000	500	31,500
	GRPH	150	100	75
	Benzene	1.4	0.5	0.7
Enhanced bioremediation	DRPH	63,000	500	3,780
	GRPH	150	100	9
	Benzene	1.4	0.5	0.08

TABLE 5-13. PROJECT DURATION FOR REMEDIAL ALTERNATIVES CONSIDERED FOR SPILL/LEAK #3 (ST07)

REMEDIAL ALTERNATIVE	DURATION OF ONSITE REMEDIAL ACTIVITY (Days)	TOTAL PROJECT DURATION (Days)
No action	0	30
Institutional controls and monitoring	23	881
Enhanced bioremediation	30	988

TABLE 5-14. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR THE COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

REMEDIAL ACTION	CONTAMINANTS	REMEDIAL ACTION EFFICIENCY	INITIAL CONCENTRATION IN SOIL (mg/kg)	TARGET CLEANUP LEVEL (mg/kg)	POST REMEDIAL CONCENTRATION (mg/kg)	BENCH OR TREATABILITY STUDY REQUIRED	LEVEL OF WORKER PROTECTION	PROJECT COST	PROJECT DURATION (Months)
No action	PCBs, Carbon tetrachloride, DRPH, and RRPH	<10%	8,010 total PCBs 17.3 Carbon tetrachloride 51,000 DRPH 43,100 RRPH	<10 total PCBs 4.92 Carbon tetrachloride 500 DRPH 2,000 RRPH	>Cleanup Levels	NO	Not Applicable	$5,750	1
Thermal desorption	PCBs, Carbon tetrachloride, DRPH, and RRPH	100%	8,010 total PCBs 17.3 Carbon tetrachloride 51,000 DRPH 43,100 RRPH	<10 total PCBs 4.92 Carbon tetrachloride 500 DRPH 2,000 RRPH	<Cleanup Levels	YES	D	$11,693,480	49[b]
Offsite treatment/ disposal	PCBs, Carbon tetrachloride, DRPH, and RRPH	100%	8,010 total PCBs 17.3 Carbon tetrachloride 51,000 DRPH 43,100 RRPH	<10 total PCBs 4.92 Carbon tetrachloride 500 DRPH 2,000 RRPH	<Cleanup Levels	NO	D	$10,395,990	8

> Greater than.
< Less than.
a The contaminants listed do not include the highly contaminated soils stored within the containment cell. The maximum concentrations of the primary contaminants in these soils is as follows: diesel range organics 118,000 mg/kg, residual range organics 174,000 mg/kg, carbon tetrachloride 3,510 mg/kg, and trichloroethene 900 mg/kg.
b Project duration assumes an excavation rate of five cubic yards/hour and a treatment rate of four tons/day.

TABLE 5-15. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SPILL/LEAK #3 (ST07)

REMEDIAL ACTION	CONTAMINANTS	REMEDIAL ACTION EFFICIENCY	INITIAL CONCENTRATION (mg/kg)	TARGET CLEANUP LEVEL (mg/kg)	POST REMEDIAL CONCENTRATION (mg/kg)	BENCH OR TREATABILITY STUDY REQUIRED	LEVEL OF WORKER PROTECTION	PROJECT COST	PROJECT DURATION (Months)
No action	DRPH	50%	63,000	500	31,500	NO	Not Applicable	$5,750	1
	GRPH	50%	150	100	75				
	Benzene	50%	1.4	0.5	0.7				
Institutional controls and monitoring	DRPH	50%	63,000	500	31,500	NO	D	$86,345	29
	GRPH	50%	150	100	75				
	Benzene	50%	1.4	0.5	0.7				
Enhanced bioremediation	DRPH	94%	63,000	500	3,780	YES	D	$168,960	33
	GRPH	94%	150	100	9				
	Benzene	94%	1.4	0.5	0.084				

5.4.5 Summary of the Nine Criteria

This section consists of an evaluation of the proposed alternatives. The alternatives are analyzed according to the following nine criteria required in the NCP:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance (not evaluated at this time); and
- Community acceptance (not evaluated at this time).

State and community acceptance will be based on comments on the RI/FS report and decision documents that will detail the proposed remedial alternative for each site.

The evaluation of the nine criteria is presented in Table 5-16 for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09); and in Table 5-17 for Spill/Leak #3 (ST07). The following definitions of the nine criteria, taken from the EPA RI/FS Guidance Document and the NCP, were used.

Overall Protection of Human Health and the Environment. This criterion addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Compliance with ARARs. This criterion addresses whether or not a remedy will meet all of the ARARs of federal and state environmental statutes and/or provide grounds for invoking a waiver.

Long-Term Effectiveness and Permanence. This criterion refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

Reduction of Toxicity, Mobility, or Volume Through Treatment. This criterion is the anticipated performance of the treatment technologies a remedy may employ (reflects the anticipated performance of treatment).

Short-Term Effectiveness. This criterion addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

Implementability. This criterion is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

TABLE 5-16. EVALUATION OF NINE CRITERIA FOR COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09)

	NO ACTION	THERMAL DESORPTION	OFFSITE TREATMENT/DISPOSAL
1. Overall Protection of Human Health and the Environment	This alternative will not be protective of human health and the environment because it does not comply with all chemical-specific ARARs. Therefore, it will not provide sufficient long-term effectiveness and permanence.	This alternative is protective of human health and the environment because it complies with all ARARs, provides long-term effectiveness and permanence, and provides short-term effectiveness.	This alternative is protective of human health and the environment because it complies with all ARARs, provides long-term effectiveness and permanence, and provides short-term effectiveness.
2. Compliance with ARARs	The use of this technology will comply with action specific and location specific ARARs, but does not provide enough reduction to comply with chemical specific ARARs.	The use of this technology will probably comply with all chemical specific, action specific, and location specific ARARs. Treatability testing will be required to see if air emissions are acceptable.	The use of this technology will comply with all chemical specific, action specific, and location specific ARARs.
3. Long-term Effectiveness and Permanence	This alternative will not provide long-term effectiveness because with no source removal, contamination of downstream tundra and the lagoon will continue.	This alternative provides sufficient long-term effectiveness because the residual COC concentrations are below relevant risk and hazard levels and are below relevant action levels. It provides permanence because COCs are removed from the contaminated medium.	This alternative provides sufficient long-term effectiveness because the residual COC concentrations are below relevant risk and hazard levels, and are below relevant action levels. It provides permanence because COCs are removed from the contaminated medium.
4. Reduction of Toxicity, Mobility, and Volume Through Treatment	None.	Results in a reduction in volume through onsite treatment and offsite treatment of condensate.	Results in a reduction in volume through offsite treatment and/or disposal.
5. Short-Term Effectiveness	This alternative will not detrimentally affect the environment, the surrounding community, or workers.	This alternative will not detrimentally affect the environment, the surrounding community, or workers. Recommended worker protection is level D.	This alternative will not detrimentally affect the local environment, the surrounding community, or workers. Recommended worker protection is level D.
6. Implementability	This alternative should be technically and administratively implementable, provided that a risk management declaring is made that COC concentrations do not warrant restoring.	Technical implementability will be determined by performing a treatability study. Administrative implementability issues includes securing permits and siting the containment cell and thermal desorption unit. Alternatives to thermal desorption include solvent extraction, which is comparable in cost. Vendors are readily available.	This technology is technically implementable. Administrative implementability issues include securing permits, and siting of the containment cell, which should be possible at the hangar area. Vendors are readily available.

TABLE 5-16. EVALUATION OF NINE CRITERIA FOR COMBINED LANDFILL AND WASTE ACCUMULATION AREA (LF01), WHITE ALICE SITE (SS03), UPPER CAMP TRANSFORMER BUILDING (SS08), AND LOWER CAMP TRANSFORMER BUILDINGS (SS09) (CONTINUED)

	NO ACTION	THERMAL DESORPTION	OFFSITE TREATMENT/DISPOSAL
7. Cost	$5,750	$11,693,480	$10,409,990
8. State/Support Agency	ADEC will be involved in review and selection of remedial alternatives.	ADEC will be involved in review and selection of remedial alternatives.	ADEC will be involved in review and selection of remedial alternatives.
9. Community Acceptance	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.

TABLE 5-17. EVALUATION OF NINE CRITERIA FOR SPILL/LEAK #3 (ST07)

SITE:	NO ACTION	INSTITUTIONAL CONTROLS AND MONITORING	ENHANCED BIOREMEDIATION
1. Overall Protection of Human Health and the Environment	This alternative may not be completely protective of human health and the environment because it does not comply with all chemical-specific ARARs. Therefore, it may not provide sufficient long-term effectiveness and permanence.	This alternative may not be completely protective of human health and the environment because it does not comply with all chemical-specific ARARs. Therefore, it may not provide sufficient long-term effectiveness and permanence.	This alternative is protective of human health and the environment because it complies with all action and location specific ARARs, reduces COC concentrations to levels below relevant risk and hazard thresholds, provides long-term effectiveness and permanence, and provides short-term effectiveness.
2. Compliance with ARARs	The use of this technology will comply with all action specific and location specific ARARs, but may not provide enough reduction to comply with all chemical specific ARARs.	The use of this technology will comply with all action specific and location specific ARARs, but may not provide enough reduction to comply with all chemical specific ARARs.	The use of this technology will comply with all action specific, and location specific ARARs. ADEC non-UST target for DRPH will not be met within the first three years but will be eventually.
3. Long-term Effectiveness and Permanence	This alternative may not provide sufficient long-term effectiveness because some residual COC concentrations are above relevant action levels.	This alternative will provide sufficient long-term effectiveness even though some residual COC concentrations are above relevant action levels, because the IRA is operated and maintained.	This alternative provides sufficient long-term effectiveness because the residual COC concentrations are below relevant risk and hazard levels, although ADEC non UST target for DRPH is not met in the first three years, it will be over time. It provides permanence because COCs are removed from the contaminated medium. This alternative includes O&M of the IRA.
4. Reduction of Toxicity, Mobility, and Volume	Results in a reduction in toxicity through natural bioremediation.	Results in a reduction in toxicity through natural bioremediation.	Results in a reduction in toxicity through treatment.
5. Short-Term Effectiveness	This alternative will not detrimentally affect the environment, the surrounding community, or workers.	This alternative will not detrimentally affect the environment, the surrounding community, or workers.	This alternative will not detrimentally affect the environment, the surrounding community, or workers. Recommended worker protection is level D.
6. Implementability	This alternative should be technically and administratively implementable, provided that a risk management decision is made that COC concentrations do not warrant monitoring.	This alternative is administratively implementable.	Technical implementability will be determined by performing a treatability study. Administrative implementability issues include securing permits. Materials are readily available.
7. Cost	$5,750	$86,345	$168,960
8. State/Support Agency	ADEC will be involved in review and selection of remedial alternatives.	ADEC will be involved in review and selection of remedial alternatives.	ADEC will be involved in review and selection of remedial alternatives.
9. Community Acceptance	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.	Community Relations Plan is being implemented and community concerns will be addressed in responsiveness summary.

Cost. Cost includes estimated capital and operation and maintenance costs, and net present work costs.

State Acceptance. State acceptance addresses the technical or administrative issues and concerns the support agency may have regarding each alternative.

Community Acceptance. Community acceptance addresses the issues and concerns the public may have regarding each of the alternatives.

5.4.6 Preferred Alternatives

The preferred remedial action alternatives for the five sites at the Cape Lisburne installation are presented in Table 5-18. The preferred alternative for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) is to excavate the material, and transport it offsite for treatment and disposal. This method is flexible in that it applies to all media, including soil, drums, liquids, and debris. Thermal desorption requires treatability testing because excessive moisture or fine-grained materials can severely reduce its effectiveness. Offsite treatment/disposal requires a much shorter duration than thermal desorption (given the assumed treatment rate of four tons/day), and may have greater community acceptance because there are no air emissions or hazards that are associated with long-term onsite treatment. In addition, offsite treatment/disposal is less costly than thermal desorption (assuming the cost of incineration does not increase).

The preferred alternative for remediating soil and gravel at Spill/Leak #3 (ST07) is enhanced bioremediation. Though more costly than the other alternatives, enhanced bioremediation offers the best short and long term effectiveness with minimal disturbance of the area. The medium is soil and gravel and the COCs are petroleum hydrocarbons, so the projected attainable cleanup level of three years may be sufficient, especially with the continued operation and maintenance of the collection and treatment system at the base of the hillside.

TABLE 5-18. PREFERRED REMEDIAL ACTION ALTERNATIVES

SITE NAME	SITE ID NUMBER	MEDIUM	RECOMMENDED ALTERNATIVE
Landfill and Waste Accumulation Area, White Alice Site, Upper Camp Transformer Building, and Lower Camp Transformer Buildings	LF01, SS03, SS08, SS09	Soil, tundra, gravel, drums, debris, and concrete pad	Offsite treatment/ disposal
Spill/Leak #3	ST07	Soil and gravel	Enhanced bioremediation

Estimated cost for performing the preferred alternatives are as follows:

• Offsite Treatment/disposal [excavated material at combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09)]	$10,409,990
• Enhanced Bioremediation [Spill/Leak #3 (ST07)]	$ 168,960
TOTAL	$10,578,950

These alternatives are considered stand-alone projects, and costs were estimated as such. If a coordinated approach to remediation is used, savings may be realized in preparation of planning documents, mobilization and demobilization, onsite labor, transportation of equipment, wastes, and samples. In addition, the volume of material that must be treated and disposed has been estimated based on RI and IRA sampling and analyses. The actual volume may be reduced by field screening during remediation or may increase if the area of buried wastes and contaminated soil is greater than estimated. It is recommended that electromagnetic surveying and additional sampling be performed to further characterize the contamination at the Landfill and Waste Accumulation Area (LF01) prior to undertaking any remedial actions.

5.5 SITING STUDY

Offsite treatment/disposal for the combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09) will require substantial areas for storing excavated materials and staging the shipping containers. This may require temporary enclosures.

Enhanced bioremediation, recommended for Spill/Leak #3 (ST07) does not require a significant staging area.

ATTACHMENT A
COST ESTIMATES

Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09)

No action	1
Thermal desorption	2
Offsite treatment/disposal	3

Spill/Leak #3 (ST07)

No action	4
Institutional controls and monitoring	5
Enhanced bioremediation	6

Alternative: No Action
Estimated Costs

Sites:
Combined Sites
(LF01, SS03, SS08, SS09)

Medium: Drums/debris/soil/gravel/tundra/concrete pad
Total volume: 2,786 CY
Project duration: 1 Month (30 days)
Discount rate: 5% *

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Total Capital Cost over the 1 Month Project				$0	$0
OPERATING COSTS:					
Closure	1	Event	$5,000.00	$5,000	
Total Operating Cost over the 1 Month Project				$5,000	$0
Total Direct Cost over the 1 Month Project				$5,000	$0
Procurement costs (0%)				$0	$0
Overhead (10%)				$500	$0
Contingency (5%)				$250	$0
Total Administrative Cost over the 1 Month Project				$750	$0
NET PRESENT WORTH					$5,750

* Estimated discount rate for calculating present value of future costs

Alternative: Thermal Desorption

Estimated Costs

Site:	Medium:	Drums/debris/soil/gravel/tundra/concrete pad	
Combined Sites	Total volume:	2786 CY	
(LF01, SS03, SS08, SS09)	Project duration:	49 Months	(1468 days)
	Discount rate:	5% *	

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Planning Documents (RD/RA) (Work plan, SAP, QAPjP, H&S)	2	Report	$10,000.00	$20,000	
Development of Specifications (Draft and Final)	2	Report	$7,500.00	$15,000	
Technology Testing	1	Event	$15,000.00	$15,000	
Drum Cost	1,349	Drum	$42.50	$57,333	
Personal H & S Expendibles	2,653	Day	$10.00	$26,534	
Misc. Equipment and Supplies	1	Lump Sum	$100.00	$100	
Backhoe	1	Month	$3,000.00	$3,000	
Staging Area (Liner & Berm)	1	Lump Sum	$5,000.00	$5,000	
Total Capital Cost over the 49 Month Project				$141,967	$0
OPERATING COSTS:					
Mobilize/Demobilize Unit	1	Event	$300,000.00	$300,000	
Transport Equipment	1	Event	$2,000.00	$2,000	
Thermal Desorption Equipment	42	Month	$60,750.00	$2,551,500	
Thermal Desorption Personnel	42	Month	$30,885.00	$1,297,170	
Thermal Desorption Supplies	42	Month	$24,150.00	$1,014,300	
Incineration of Condensate	1,349	Drum	$500.00	$674,500	
Transportation of Wastes	1	Event	$150,000.00	$150,000	
Waste Profiling	1	Event	$750.00	$750	
Documentation	1	Event	$200.00	$200	
Labor (Oversight and Sampling)	21,275	Hr	$70.00	$1,489,264	
Per Diem	2,657	Day	$175.00	$465,045	
Backhoe Operator	568	Hr	$50.00	$28,400	
Sampling and Analysis	20	Sample	$200.00	$4,000	
Project Management	3,191	Hr	$70.00	$223,390	
Closure	1	Report	$10,000.00	$10,000	
Total Operating Cost over the 49 Month Project				$8,210,519	$0
Total Direct Cost over the 49 Month Project				$8,352,485	$0
Procurement costs (5%)				$417,624	$0
Overhead (10%)				$835,249	$0
Contingency (25%)				$2,088,121	$0
Total Administrative Cost over the 49 Month Project				$3,340,994	$[illegible]
NET PRESENT WORTH					**$11,693,479**

* Estimated discount rate for calculating present value of future costs

Alternative: Offsite Treatment/Disposal
Estimated Costs

Site:	Medium:	Drums/debris/soil/gravel/tundra/concrete pad
Combined Sites	Total volume:	2786 CY
(LF01, SS03, SS08, SS09)	Project duration:	8 Months (235 days)
	Discount rate:	5% *

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Planning Documents (RD/RA) (Work plan, SAP, QAPjP, H&S)	2	Report	$10,000.00	$20,000	
Development of Specifications (Draft and Final)	2	Report	$7,500.00	$15,000	
Super Sacks	2,787	Sack	$40.00	$9,290	
Personal H & S Expendibles	188	Day	$10.00	$1,880	
Misc. Equipment and Supplies	1	Lump Sum	$100.00	$100	
Staging Area (Liner & Berm)	1	Lump Sum	$5,000.00	$5,000	
Backhoe	1	Month	$3,000.00	$3,000	
Drums	20	Drum	$42.50	$850	
Total Capital Cost over the 8 Month Project				$55,120	$0
OPERATING COSTS:					
Mobilize/Demobilize	1	Event	$140,000.00	$140,000	
Transport Equipment	1	Event	$2,000.00	$2,000	
Transport Wastes	1	Event	$400,000.00	$400,000	
Land Disposal (PCB & TPH Solids)	647	Ton	$100.00	$64,700	
Incineration (F-Listed Solids)	4,368	Ton	$1,500.00	$6,552,000	
Incineration (Liquids)	20	Drums	$500.00	$10,000	
Waste Profiling	1	Event	$750.00	$750	
Documentation	1	Event	$200.00	$200	
Labor (Oversight and Sampling)	1,552	Hr	$70.00	$108,640	
Backhoe Operator	568	Hr	$50.00	$28,400	
Per Diem	192	Day	$175.00	$33,600	
Sampling and Analysis	20	Sample	$200.00	$4,000	
Project Management	233	Hr	$70.00	$16,296	
Closure	1	Report	$10,000.00	$10,000	
Total Operating Cost over the 8 Month Project				$7,370,586	$0
Total Direct Cost over the 8 Month Project				$7,425,706	$0
Procurement costs (5%)				$371,285	$0
Overhead (10%)				$742,571	$0
Contingency (25%)				$1,856,427	$0
Total Administrative Cost over the 8 Month Project				$2,970,282	$0
NET PRESENT WORTH					**$10,395,988**

* Estimated discount rate for calculating present value of future costs

Alternative: No Action

Estimated Costs

Sites:	Medium:	Soil and Gravel	
Spill/Leak #3 (ST07)	Total volume:	10,000 CY	
	Project duration:	1 Month	(30 days)
	Discount rate:	5% *	

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Total Capital Cost over the 1 Month Project				$0	$0
OPERATING COSTS:					
Closure	1	Event	$5,000.00	$5,000	
Total Operating Cost over the 1 Month Project				$5,000	$0
Total Direct Cost over the 1 Month Project				$5,000	$0
Procurement costs (0%)				$0	$0
Overhead (10%)				$500	$0
Contingency (5%)				$250	$0
Total Administrative Cost over the 1 Month Project				$750	$0
NET PRESENT WORTH					**$5,750**

* Estimated discount rate for calculating present value of future costs

Alternative: Institutional Controls and Monitoring
Estimated Costs

Site:	Media:	Soil and gravel	
Spill/Leak #3 (ST07)	Total volume:	10,000 CY	
	Project duration:	29 Months	(881 days)
	Discount rate:	5% *	

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Planning Documents (Work plan, SAP, QAPjP, H&S)	2	Report	$5,000.00	$10,000	
Misc. Equipment and Supplies	1	Lump Sum	$100.00	$100	
Total Capital Cost over the 29 Month Project				$10,100	$0
OPERATING COSTS:					
Implement Institutional Controls	1	Event	$10,000.00	$10,000	
Sampling	3	Event	$280.00		$840
Labor	400	Hr	$70.00	$28,000	
Per Diem	46	Days	$175.00	$8,050	
Project Management	60	Hr	$70.00	$4,200	
Closure (Month 29)	1	Report	$5,000.00	$5,000	
Travel for Sampling	6	Trips	$1,200.00		$7,200
Total Operating Cost over the 29 Month Project				$55,250	$8,040
Total Direct Cost over the 29 Month Project				$65,350	$8,040
Procurement costs (5%)				$3,268	$402
Overhead (10%)				$6,535	$804
Contingency (10%)				$6,535	$804
Total Administrative Cost over the 29 Month Project				$16,338	$2,010
NET PRESENT WORTH					**$86,343**

* Estimated discount rate for calculating present value of future costs

Alternative: Enhanced Bioremediation
Estimated Costs

Sites:	Media:	Soil and Gravel	
Spill/Leak #3 (ST07)	Total volume:	10,000 CY	
	Project duration:	33 Months	(988 days)
	Discount rate:	5% *	

Description	Quantity	Units	Unit Cost	Fixed Cost	Annual Cost
CAPITAL COSTS:					
Planning Documents (RD/RA) (Work plan, SAP, QAPjP, H&S)	3	Report	$5,000.00	$15,000	
Develop Specifications (30%, 95%, 100%)	3	Report	$5,000.00	$15,000	
Permitting (Air or Water)	1	Permit	$2,000.00	$2,000	
Treatability study	1	Study	$7,500.00	$7,500	
Nutrients	4,000	Lb	$1.00	$4,000	
Empty sand bags	83	Bag	$0.47	$39	
Hose	1	Hose	$50.00	$50	
Booms	5	Boom	$24.53	$123	
Trash pump	2	Month	$420.00	$840	
Personal H & S Expendibles	46	Day	$10.00	$460	
Misc. Equipment and Supplies	1	Lump Sum	$1,000.00	$1,000	
Total Capital Cost over the 33 Month Project				$46,012	$0
OPERATING COSTS:					
Mobilize/Demobilize	1	Event	$30,000.00	$30,000	
Transport Nutrients					
Transport Equipment					
Labor	528	Hr	$70.00	$36,960	
Per diem	50	Day	$175.00	$8,750	
Sampling & Analysis (initial)	4	Sample	$70.00	$280	
Sampling & Analysis (annual)	2	Event	$280.00		$560
Travel for Sampling	4	Trips	$1,200.00		$4,800
Project Management	79	Hr	$70.00	$5,544	
Closure (Month 33)	1	Report	$5,000.00		$5,000
Total Operating Cost over the 33 Month Project				$81,534	$10,360
Total Direct Cost over the 33 Month Project				$127,546	$10,360
Procurement costs (5%)				$6,377	$518
Overhead (10%)				$12,755	$1,036
Contingency (10%)				$12,755	$1,036
Total Administrative Cost over the 33 Month Project				$31,886	$2,590
NET PRESENT WORTH					**$168,962**

* Estimated discount rate for calculating present value of future costs

ATTACHMENT B
ESTIMATED DURATION

Combined Landfill and Waste Accumulation Area (LF01), White Alice Site (SS03), Upper Camp Transformer Building (SS08), and Lower Camp Transformer Buildings (SS09)

No action	1
Thermal desorption	2
Offsite treatment/disposal	3

Spill/Leak #3 (ST07)

No action	4
Institutional controls and monitoring	5
Enhanced bioremediation	6

Alternative: No Action
Estimated Project Duration

Sites:
Combined Site (LF01, SS03, SS08, SS09)

Start Date: Day 1
Medium: Drums/debris/soil/gravel/tundra/concrete pad

Activity	Duration	Start Date	End Date
Develop Closure Report	30 Days	Day 1	Day 30
Secure Closure	0 Days	Day 30	Day 30
PROJECT DURATION	30 Days		

Alternative: Thermal Desorption
Estimated Project Duration

Site:
Combined Sites (LF01, SS03, SS08, SS09)

Start Date: Day 1
Medium: Drums/debris/soil/gravel/tundra/concrete pad

Activity	Duration	Start Date	End Date
Development of Planning Documents	90 Days	Day 1	Day 90
Development of Specifications	60 Days	Day 1	Day 60
Mobilize	14 Days	Day 91	Day 104
Preliminary Sampling	1 Days	Day 105	Day 105
Remediation	1325 Days	Day 106	Day 1430
Final Sampling	1 Days	Day 1431	Day 1431
Demobilize	7 Days	Day 1432	Day 1438
Develop Closure Report	30 Days	Day 1439	Day 1468
Secure Closure	0 Days	Day 1468	Day 1468
PROJECT DURATION	1468 Days		

Alternative: Offsite Treatment/Disposal
Estimated Project Duration

Site:
Combined Site (LF01, SS03, SS08, SS09)

Start Date: Day 1
Medium: Drums/debris/soil/gravel/tundra/concrete pad

Activity	Duration	Start Date	End Date
Development of Planning Documents	90 Days	Day 1	Day 90
Development of Specifications	60 Days	Day 1	Day 60
Mobilize	14 Days	Day 91	Day 104
Preliminary Sampling	1 Days	Day 105	Day 105
Remediation	92 Days	Day 106	Day 197
Final Sampling	1 Days	Day 198	Day 198
Demobilize	7 Days	Day 199	Day 205
Develop Closure Report	30 Days	Day 206	Day 235
Secure Closure	0 Days	Day 235	Day 235
PROJECT DURATION	235 Days		

Alternative: No Action
Estimated Project Duration

Sites:
Spill/Leak #3 (ST07)

Start Date: Day 1
Medium: Soil and Gravel

Activity	Duration	Start Date	End Date
Develop Closure Report	30 Days	Day 1	Day 30
Secure Closure	0 Days	Day 30	Day 30
PROJECT DURATION	30 Days		

Alternative: Institutional Controls and Monitoring
Estimated Project Duration

Site:
Spill/Leak #3 (ST07)

Start Date: Day 1
Medium: Soil and gravel

Activity	Duration	Start Date	End Date
Development of Planning Documents	60 Days	Day 1	Day 60
Implementation of Procedural Institutional Controls	50 Days	Day 61	Day 110
Mobilization	2 Days	Day 111	Day 112
Preliminary Sampling & Construction of Physical Institutional Controls	13 Days	Day 113	Day 125
Demobilization	2 Days	Day 126	Day 127
End of First Year Sampling	3 Days	Day 487	Day 489
End of Second Year Sampling	3 Days	Day 849	Day 851
Development of Closure Report	30 Days	Day 852	Day 881
Closure	0 Days	Day 881	Day 881
PROJECT DURATION	881 Days		

Alternative: Enhanced Bioremediation
Estimated Project Duration

Sites:
Spill/Leak #3 (ST07)

Start Date: Day 1
Media: Soil and Gravel

Activity	Duration	Start Date	End Date
Treatability Study	60 Days	Day 1	Day 60
Development of Planning Documents	90 Days	Day 61	Day 150
Development of Specifications	60 Days	Day 61	Day 120
Permits	60 Days	Day 151	Day 210
Mobilization	7 Days	Day 211	Day 217
Preliminary Sampling	3 Days	Day 218	Day 220
Application of Nutrients, Microbes, and Water	7 Days	Day 221	Day 227
Demobilization	7 Days	Day 228	Day 234
End of First Year Sampling	3 Days	Day 594	Day 596
End of Second Year Sampling	3 Days	Day 956	Day 958
Development of Closure Report	30 Days	Day 959	Day 988
Closure	0 Days	Day 988	Day 988
PROJECT DURATION	988 Days		

APPENDIX A

REFERENCES AND LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASUREMENT

REFERENCES

Alaska Biological Research. 1994. Spectacled and Steller's Eiders Surveys at 11CEOS Remote Sites in Alaska, 1994. Fairbanks, Alaska. September 30, 1994.

Alaska Department of Environmental Conservation. 1989. Water Quality Standards 18 AAC 70. Prepared for the Triennial Review required by the Federal Clean Water Act (December 1989).

Alaska Department of Environmental Conservation. 1991. Interim Guidance for Non-UST Contaminated Soil Cleanup Levels. Guidance No. 001 - Revision No. 1, 17 July 1991. Table 2 (North Slope Numeric Cleanup Levels).

Alaska Department of Environmental Conservation. 1992. Comments on Cape Lisburne Long Range Radar Station Fuel Spill. Correspondence from Laura Noland of ADEC to Lt. Colonel Patrick M. Coullahun of the U.S. Air Force. 17 November.

Alaska Department of Fish and Game. 1986. Alaska Habitat Management Guide.

Alaska Department of Fish and Game. 1992. Catalog of Waters Important for Spawning, Rearing, or Migrations of Androgenous Fishes. Arctic Region Resource Management Region V.

Alaska Department of Labor. 1990. 1980-1990 Census and Estimates of the North Slope Borough.

Alaska Natural Heritage Program. 1993. List and Definitions of Federal and State "Listed" Species Status. Facsimile Transmission 5 November 1993.

American Cancer Society. 1993. Cancer Facts and Figures - '93. American Cancer Society, Atlanta, Georgia.

American Geological Institute. 1972. Glossary of Geology. Washington, D.C.

APHA, AWWA. 1989. Standard Methods for the Examination of Water and Wastewater. 17th Edition.

Atlas, R.M. 1985. Effects of Hydrocarbons on Microorganisms and Petroleum Biodegradation in Arctic Ecosystems. F.R. Engelhardt, Ed. Petroleum Effects in the Arctic Environment. Canada Oil and Gas Lands Administration, Ottawa, Ontario, Canada.

Barnack, K., Capt. 1991. Environmental Questionnaire.

Bergman, R.D., R.L. Howard, K.F. Abraham, and M.W. Weller. 1977. Water Birds and their Wetland Resources in Relation to Oil Development at Storkersen Point, Alaska. U.S. Fish and Wildlife Service Resource Publication 129. Washington, D.C.

CH2M Hill. 1981. Installation Restoration Program Search, Alaska DEW Line Stations. Prepared for the U.S. Air Force.

REFERENCES (CONTINUED)

Dames and Moore. 1986. Installation Restoration Program, Phase II, Stage 1 - Confirmation/ Quantification. Prepared for USAFOEHL/TS.

Dames and Moore. 1987. Installation Restoration Program, Phase II, Stage 2 - Confirmation/ Quantification. Prepared for USAFOEHL/TS.

Delorme Mapping. 1992. Alaska Atlas and Gazetteer. First Edition. Second Printing.

Dingman, S.L., R.G. Barry, G. Weller, C. Benson, E.F. LeDrew, and C. Goodwin. 1980. Climate, Snow Cover, Microclimate, and Hydrology. In J. Brown et al. (Eds.), An Arctic Ecosystem: The Coastal Tundra at Barrow, Alaska. US/IBP Synthesis Series No. 12. Dowden, Hutchinson, and Ross. Stroudsburg, Pennsylvania.

Engineering Science. 1985. Installation Restoration Program, Phase 1 - Records Search ACC - Northern Region; Galena AFS, Campion AFS, Cape Lisburne AFS, Fort Yukon AFS, Indian Mountain AFS, Kotzebue AFS, Murphy Rome AFS, Tin City AFS. Prepared for the USAF Engineering Service Center.

Evans, D., R. Elder, and R. Hoffman. 1992. Bioremediation of Diesel Contamination Associated with Oil and Gas Operations. Gas, Oil, and Environmental Biotechnology IV.

Everett, K.R. and R.J. Parkinson. 1977. Soil and Landform Associations, Prudhoe Bay Area, Alaska. Arctic and Alpine Research, 9: pp. 1-19.

Fuelner, A.J. and J.R. Williams. 1967. Development of a Ground Water Supply at Cape Lisburne, Alaska, by Modification of the Thermal Regime of Permafrost. U.S. Geological Survey Professional Paper 575-B, pp. 199-202.

Fuelner, A.J. and J.R. Williams. 1979. Further Notes on the Ground Water Supply Beneath Selin Creek Near Cape Lisburne, Northwest Alaska. U.S. Geological Survey Circular 823-B, pp. B12-B14.

Feulner, A.J., J.M. Childers, and V.W. Norman. 1971. Water Resources of Alaska. U. Geological Survey Open-File Report 71-105.

Frankenberger, W.T., Jr., K.D. Emerson, and D.W. Turner. 1989. In-Situ Bioremediation of an Underground Diesel Fuel Spill: A Case History. Environmental Management, 13(3)325-332.

Grantz, A., P.W. Barnes, D.A. Dinter, M.B. Lynch, E. Reminitz, and E.W. Scott. 1980. Geologic Framework; Hydrocarbon Potential, Environmental Conditions, and Anticipated Technology for Exploration and Development of the Beaufort Shelf North of Alaska. U.S. Geological Survey Open-File Report 80-94.

REFERENCES (CONTINUED)

Grantz, A., P.W. Barnes, D.A. Dinter, M.B. Lynch, E. Reminitz, and E.W. Scott. 1982. Geologic Framework; Hydrocarbon Potential and Environmental Conditions for Exploration and Development of Proposed Oil and Gas Lease Sale in the Beaufort and Northeast Chukchi Seas. U.S. Geological Survey Open-File Report 82-48.

Hall, E.S., Jr. 1982. Preliminary Archeological and Historical Resource Reconnaissance of the Coastal Plain Area of the Arctic National Wildlife Refuge, Alaska. U.S. Geological Survey.

Hart Crowser. 1987. Environmental Assessment for North Warning System. Alaska.

Hull, R.N. and G.W. Suter II. 1994. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment Associated Biota: 1994 Revision. ORNL Environmental Restoration Program. ES/ER/TM-95/R1.

Hussey, K.M. and R.W. Michaelson. 1966. Tundra Relief Features Near Point Barrow, Alaska. Arctic. V. 19, pp. 162-184.

IRIS. 1995. Integrated Risk Information System. Environmental Criterion Assessment Office, U.S. Environmental Protection Agency. Cincinnati, Ohio.

Jacobson, M.J. and C. Wentworth. 1982. Kaktovik Subsistence: Land Use Values Through Time in the Arctic National Wildlife Refuge Area. U.S. Fish and Wildlife Service, Northern Alaska Ecological Services, Fairbanks.

Johnston, G.H. and R.J.F. Brown. 1964. Effect of a Lake on Distribution of Permafrost in the Mackenzie River Delta. Arctic, V. 17, No. 3, pp. 162-175.

Jorgenson, M.T., L. Krizan, and M. Joyce. 1991. Bioremediation and Tundra Restoration After an Oil Spill in the Kuparuk Oil Field, Alaska, 1990. Conference paper, Environ Canada Arctic & Marine Oil Spill Program, 14th Technical Seminar, Vancouver, B.C.

Jorgenson, M.T., T. Carter, M. Royce, and S. Ronzio. 1992. Cleanup and Bioremediation of a Crude-Oil Spill at Prudhoe Bay, Alaska.

Liddell, B.V., D.R. Smallbeck, and P.C. Ramert. 1991. Arctic Bioremediation: A Case Study. Proceedings of the 1991 SPE Annual Technical Conference and Exhibition.

Livingstone, D.A. 1954. On the Orientation of Lake Basins. American Journal of Science. V. 252, pp. 547-554.

Manahan, S.E. 1991. Environmental Chemistry. Lewis Publishers, Inc., Chelsea, Minnesota. Pp. 45-47.

Metcalf and Eddy. 1986. Environmental Assessment for North Warning System Short Range Radar Prototype. Barter Island, Alaska.

REFERENCES (CONTINUED)

Miller, M.C., R.T. Prentki, and R.J. Barsdale. 1980. Chapter 3 - Physics. In J.E. Hobbie (Ed.), Limnology of Tundra Ponds, Barrow, Alaska. Dowden, Hutchinson, and Ross, Inc., Stroudsburg, Pennsylvania.

MITRE. 1990. General Guidance for Ecological Risk Assessment at Air Force Installations. Prepared by The MITRE Corporation, Brooks Air Force Base, Texas; Prepared for Human Systems Division IRP Program Office, Brooks Air Force Base, Texas (December 1990).

Murray, P.F. and R. Lipkin. 1987. Candidate Threatened and Endangered Plants of Alaska. USF&W, NPS, BLM, and USFS publication.

National Petroleum Reserve in Alaska Task Force. 1978. 105(c) Land Use Study, Volume 2: Values and Resources Analysis. U.S. Department of the Interior. Anchorage, Alaska.

National Petroleum Reserve in Alaska Task Force. 1979. 105(c) Final Study, Volume 1: Summaries of Studies. U.S. Department of the Interior. Anchorage, Alaska.

North Slope Borough. 1980. Qiniqtuagaksrat Utuqqanaat Inuuniagninisiqun, The Traditional Land Use Inventory for the Mid-Beaufort Sea, Volume 1. Commission on History and Culture, Barrow, Alaska.

Opresko, D.M., B.E. Sample, and G.W. Suter II. 1994. Toxicological Benchmarks for Wildlife: 1994 Revision. ORNL Environmental Restoration Program. ES/ER/TM-86/R1.

Osterkamp, T.E. and M.W. Payne. 1981. Estimates of Permafrost Thickness from Well Logs in Northern Alaska. Cold Regions Science and Technology, Volume 5, pp. 13-27.

PEMCO. 1993. Vendor Brochure. Soil Remediation Division. Project Summary, Newport, Oregon. 11 October 1993.

Pewe, Troy L. 1975. Quaternary Geology of Alaska. U.S. Geological Survey Professional Paper 835.

Ratliff, M.D. 1993. Construction and Operation of a Biological Treatment Cell for the Treatment of Hydrocarbon-Contaminated Soil in Alaska. Society of Petroleum Engineers, Conference Paper SPE 25998; SPE/EPA, Exploration & Production Environmental Conference. San Antonio, Texas.

Robertson, Scott B. 1988. Hydrology of Arctic Wetlands. ASWM Technical Report, p. 262-269.

Selkregg, L.L. 1975. Alaska Regional Profiles. Volume II Arctic Region.

Shannon and Wilson, Inc. 1992. Environmental Site Assessment, Weather Station Building, BAR-Main, Barter Island, Alaska. Prepared for University of Alaska, Fairbanks. September.

REFERENCES (CONTINUED)

Song, Hong-Gyu, X. Wang, and R. Bartha. 1990. Bioremediation Potential of Terrestrial Fuel Spills. Applied and Environmental Microbiology, 56(3)652-656.

Spetzman, L.A. 1959. Vegetation of the Arctic Slope of Alaska. USGS Professional Paper 302-B.

Suter, G.W. and J.B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Tesoro/PES. 1992. Tesoro Kenai Refinery Case History. Prepared by Petroleum Environmental Services.

Tesoro/PES. 1993. Shoreline Restoration Project, Beach Segment LA-19A. Prince William Sound, Alaska. Prepared by Petroleum Environmental Services.

University of Alaska, Arctic Environmental Information and Data Center. 1978. Kaktovik, pp. 2-29.

U.S. Air Force. 1991. Handbook to Support the Installation Restoration Program (IRP) Statements of Work. Installation Restoration Program Division, Human Systems Program Office, Human Systems Division, Brooks Air Force Base, Texas (May 1991).

U.S. Air Force. 1993a. Work Plan for DEW Line and Cape Lisburne Radar Stations. Delivery Order 22. Prepared for U.S. Air Force Center of Environmental Excellence, Environmental Restoration Program Office, Brooks Air Force Base, Texas. Prepared by ICF Technology Incorporated.

U.S. Air Force. 1993b. Sampling and Analysis Plan DEW Line and Cape Lisburne Radar Stations. Delivery Order 22. Prepared for U.S. Air Force Center of Environmental Excellence, Environmental Restoration Program Office, Brooks Air Force Base, Texas. Prepared by ICF Technology Incorporated.

U.S. Air Force. 1993c. Health and Safety Plan DEW Line and Cape Lisburne Radar Stations. Delivery Order 22. Prepared for U.S. Air Force Center of Environmental Excellence, Environmental Restoration Program Office, Brooks Air Force Base, Texas. Prepared by ICF Technology Incorporated.

U.S. Air Force. 1995. Final Interim Remedial Action Report, Cape Lisburne Radar Installation, Alaska. Delivery Order 22. Prepared for U.S. Air Force Center of Environmental Excellence, Environmental Restoration Program Office, Brooks Air Force Base, Texas. Prepared by ICF Technology Incorporated.

U.S. Air Force. 1996. Final Risk Assessment, Cape Lisburne Radar Installation, Alaska. Delivery Order 22. Prepared for U.S. Air Force Center of Environmental Excellence, Environmental Restoration Program Office, Brooks Air Force Base, Texas. Prepared by ICF Technology Incorporated. February 1996.

REFERENCES (CONTINUED)

U.S. Department of the Interior. 1988. Alaska Maritime National Wildlife Refuge Draft Comprehensive Conservation Plan, Wilderness Review and Environmental Impact Statement, Volume 2. Chukchi Sea Unit.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020. March 1983.

U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste (Physical Chemical Methods). Third Edition, EPA SW-846, September 1986.

U.S. Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency. 1989a. Laboratory Data Validation Guidelines for Evaluating Inorganic Analyses. EPA Hazardous Site Evaluation Division. October 1989.

U.S. Environmental Protection Agency. 1990. Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses. EPA Hazardous Site Evaluation Division. December 1990.

U.S. Environmental Protection Agency. 1991a. Region 10 Supplemental Risk Assessment Guidance for Superfund. Region 10, U.S. Environmental Protection Agency, Seattle, Washington (August 16, 1991).

U.S. Environmental Protection Agency. 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Office of Solid Waste and Emergency Response. Washington D.C. April 22, 1991.

U.S. Environmental Protection Agency. 1991c. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals. Office of Solid Waste and Emergency Response. Washington D.C. December 13, 1991.

U.S. Environmental Protection Agency. 1992. Framework for Ecological Risk Assessment. U.S. Environmental Protection Agency, Washington D.C. (February 1992).

U.S. Fish and Wildlife Service. 1982. Arctic National Wildlife Refuge Coastal Plain Resource Assessment - Initial Report, Baseline Study of Fish, Wildlife, and Their Habitats. U.S. Department of the Interior. Anchorage, Alaska.

U.S. Fish and Wildlife Service, Federal Subsistence Board. 1992. Subsistence Management for Federal Public Lands in Alaska, Final Environmental Impact Statement.

U.S. Geologic Survey. 1955 (minor revision 1985). Barter Island (A-5) Quadrangle, Alaska, 1:63,360 Series (Topographic).

REFERENCES (CONTINUED)

U.S. Geological Survey. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. USGS Water-Supply Paper 2254. Third Edition.

Vanguard Enterprises, Inc. 1991. Vanguard Microbial Bioremediator.

Wahrhaftig, Clyde. 1965. Physiographic Divisions of Alaska. U.S. Geological Survey Professional Paper 482.

Walker, D.A., K.R. Everett, P.J. Webber, and J. Brown. 1980. Geobotanical Atlas of the Prudhoe Bay Region, Alaska. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Report 80-14.

Washington State Department of Ecology. 1992. Total Petroleum Hydrocarbons Analytical Methods for Soil and Water, April 1992.

Williams, John R. 1970. Ground Water in the Permafrost Regions of Alaska. U.S. Geological Survey Professional Paper 696.

Woodward-Clyde Consultants. 1988. Technical Support Document for Record of Decision. Cape Lisburne, AFS.

Woodward-Clyde Consultants. 1993. Natural Resources Plan: North Coastal Long Range Radar Sites. Final Draft. Prepared for the United States Air Force.

Woodward-Clyde Consultants. 1992. Draft Site Investigation Report. Cape Lisburne Long Range Radar Stations, Alaska.

Wynne, K. 1992. Guide to Marine Mammals of Alaska. University of Alaska, Fairbanks. 75 pp.

LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASUREMENT

AAC	Alaskan Air Command
ADEC	Alaska Department of Environmental Conservation
AFCEE	Air Force Center for Environmental Excellence
Air Force	United States Air Force
AMNWR	Alaska Maritime National Wildlife Refuge
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
BDAT	Best Demonstrated Available Technology
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CCW	Constituent Concentrations in Waste
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	Chemical of Concern
CT&E	Commercial Testing & Engineering Co.
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DOD	Department of Defense
DRO	Diesel Range Organics
DRPH	Diesel Range Petroleum Hydrocarbons
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
FWPCA	Federal Water Pollution Control Act
GC/MS	Gas Chromatography/Mass Spectrometry
GRAs	General Response Actions
GRO	Gasoline Range Organics
GRPH	Gasoline Range Petroleum Hydrocarbons
HARM	Hazard Assessment Rating Methodology
HQ	Hazard Quotient
HRS	Hazard Ranking System
HVOC	Halogenated Volatile Organic Compound
ICP	Inductively Coupled Plasma
IDW	Investigation Derived Waste
IRA	Interim Remedial Action
IRP	Installation Restoration Program
LRR	Long Range Radar
MSL	Mean Sea Level
NCP	National Contingency Plan
NFA	No Further Action
NPL	National Priority List

LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASUREMENT (CONTINUED)

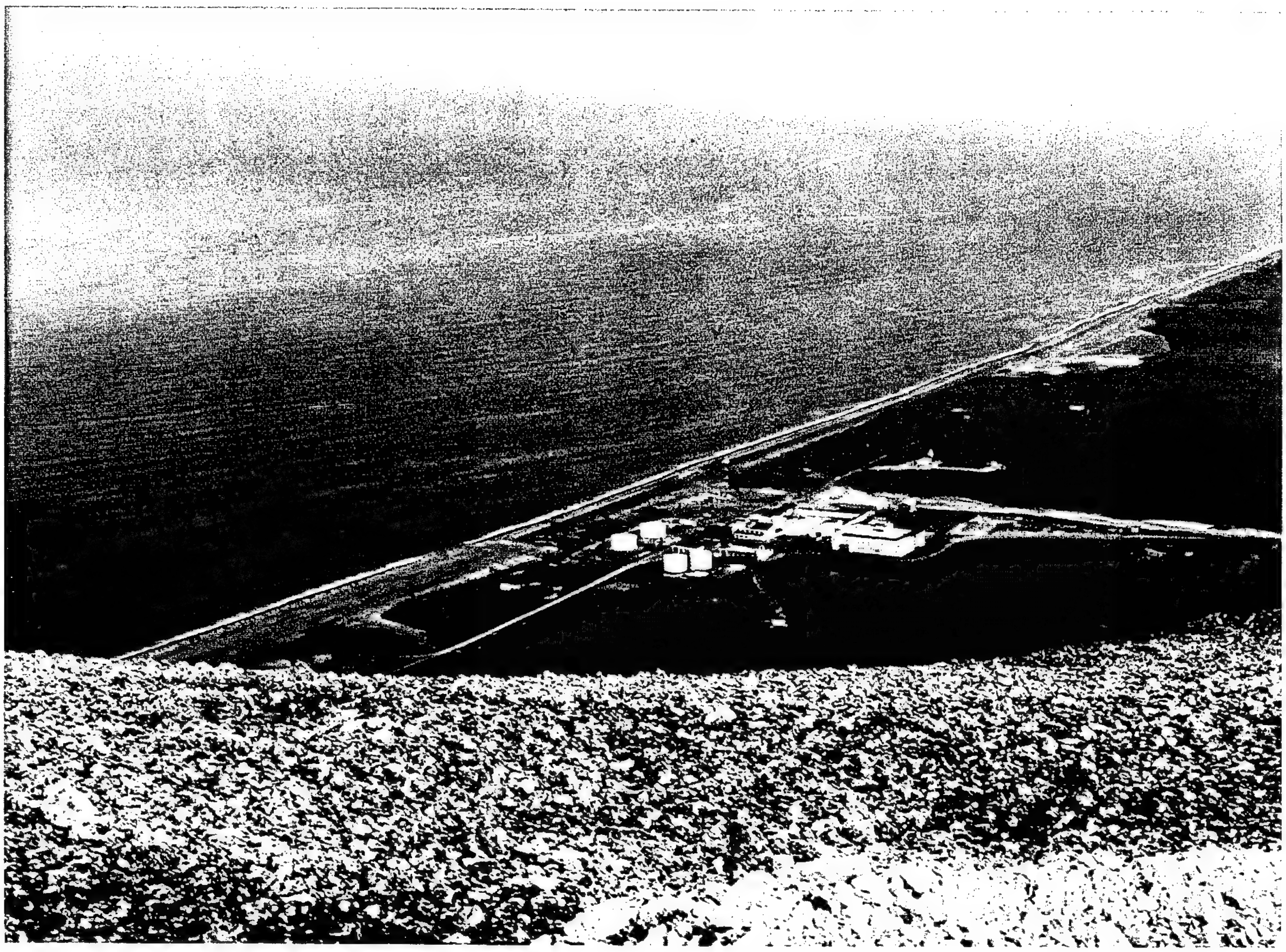
PCBs	Polychlorinated Biphenyls
QAPjP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RBSLs	Risk-Based Screening Levels
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation
RRPH	Residual Range Petroleum Hydrocarbons
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SOPs	Standard Operating Procedures
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRVs	Toxicity Reference Values
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
VOC	Volatile Organic Compound
WACS	White Alice Communications System

MEASUREMENTS

µg/L	micrograms per liter
cy	cubic yards
gpm	gallons per minute
mg/kg	miligrams per kilogram
ppb	parts per billion
ppm	parts per million

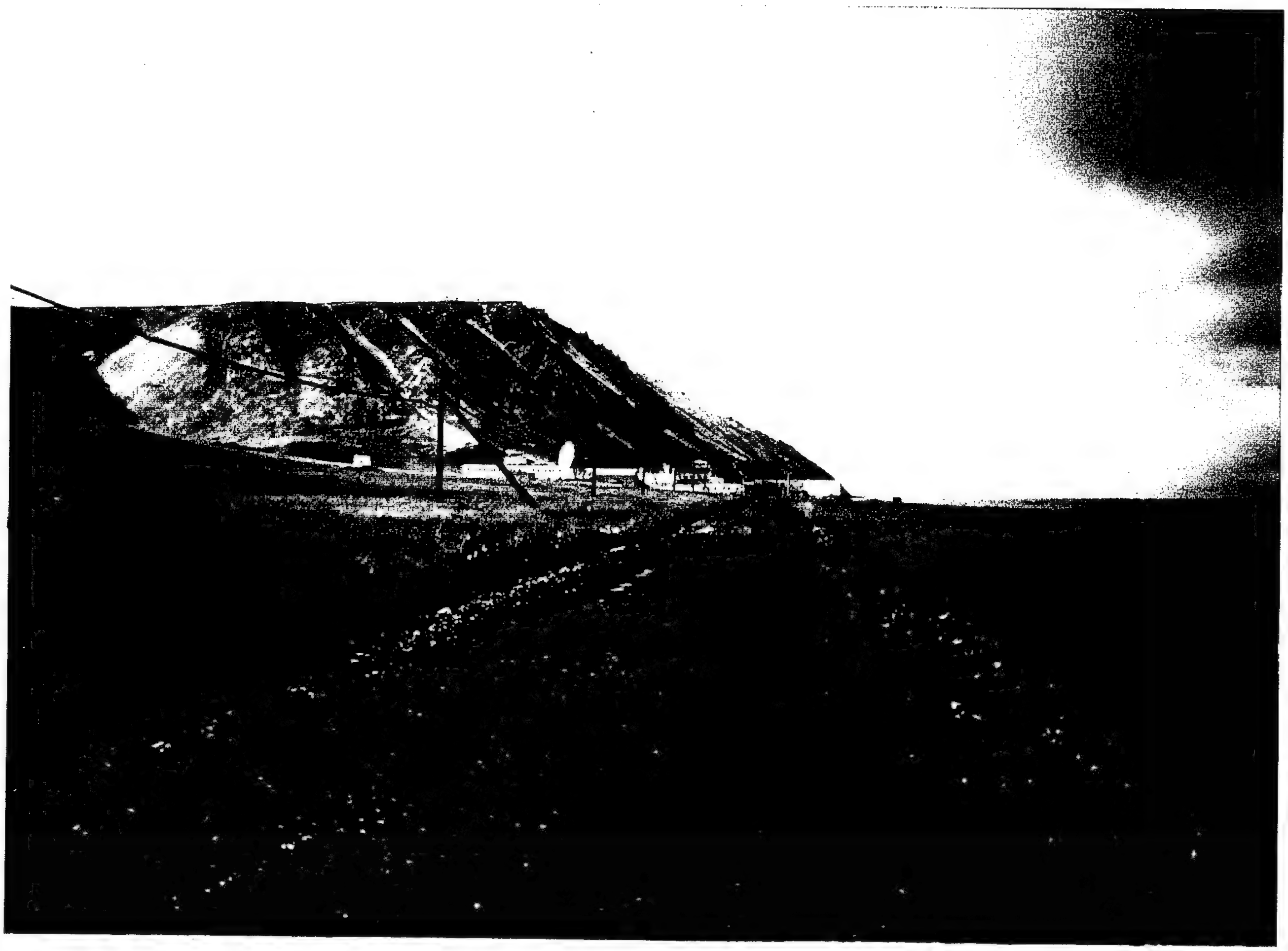
APPENDIX B

PHOTOGRAPHS OF CAPE LISBURNE RADAR INSTALLATION AND SITES



A view to the northeast of the lower camp at the Cape Lisburne radar installation from the upper camp.

A view to the west of the upper camp area at the Cape Lisburne radar installation from the Landfill and Waste Accumulation Area (LF01) site.



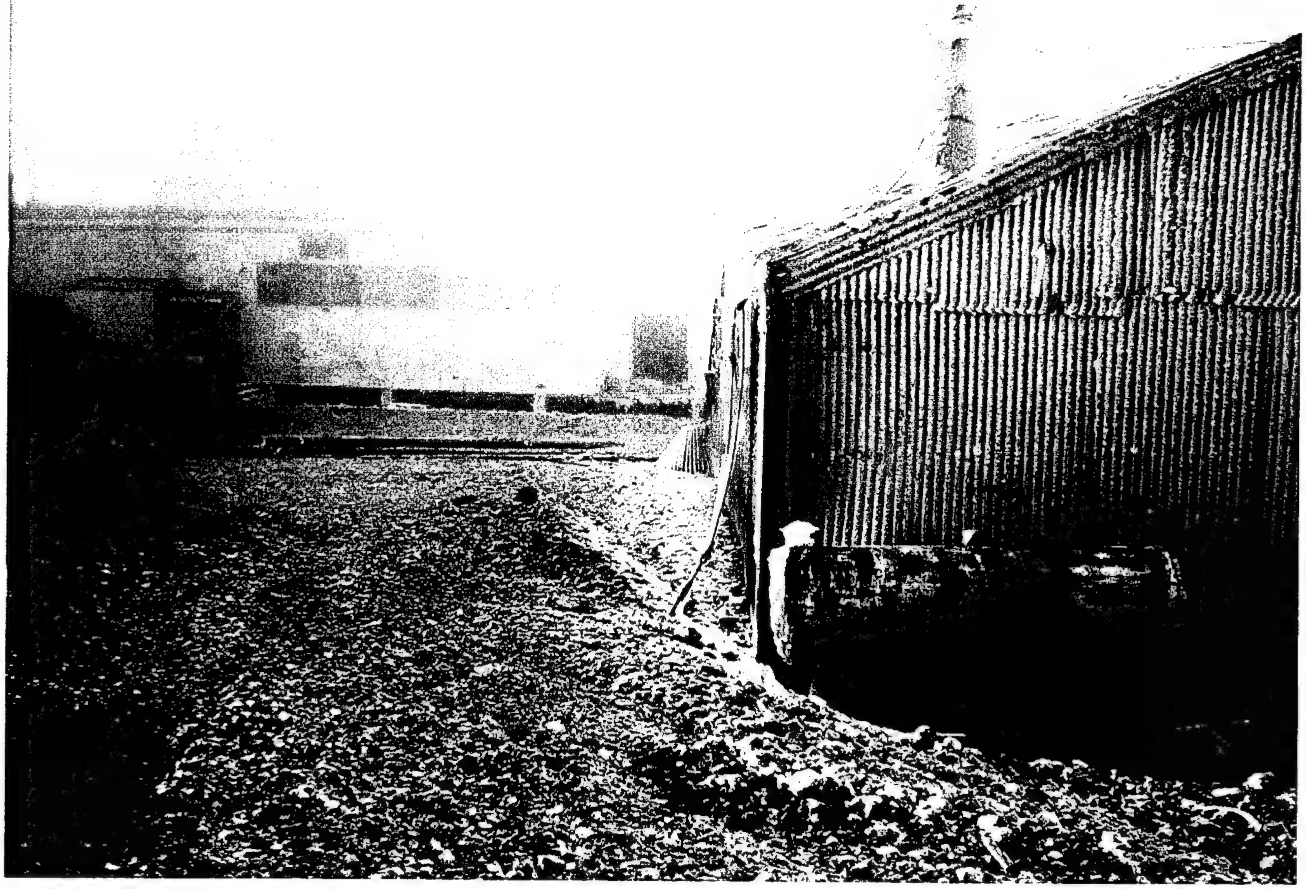
A view to the west of the Cape Lisburne radar installation. A section of the Landfill and Waste Accumulation Area (LF01) site can be seen on the right side of the gravel road.

A view to the northwest of the buried drum area at the Landfill and Waste Accumulation Area (LF01) prior to Interim Remedial Actions (IRA) at the site. IRA actions at this site in May 1995 included excavation and containment of approximately 100 drums and associated contaminated soils.

A view to the northwest of the buried drum area after excavation at the Landfill and Waste Accumulation Area (LF01). Clean gravel from the installation's quarry was used to backfill the excavation. The disturbed areas were seeded and fertilized as part of IRA activities.

A view to the north of gravel covered area #1 at the Landfill and Waste Accumulation Area (LF01).

A view to the northwest of gravel covered area #2 at the Landfill and Waste Accumulation Area (LF01). The gravel covered area #1 is located in the middle left side of the photo.

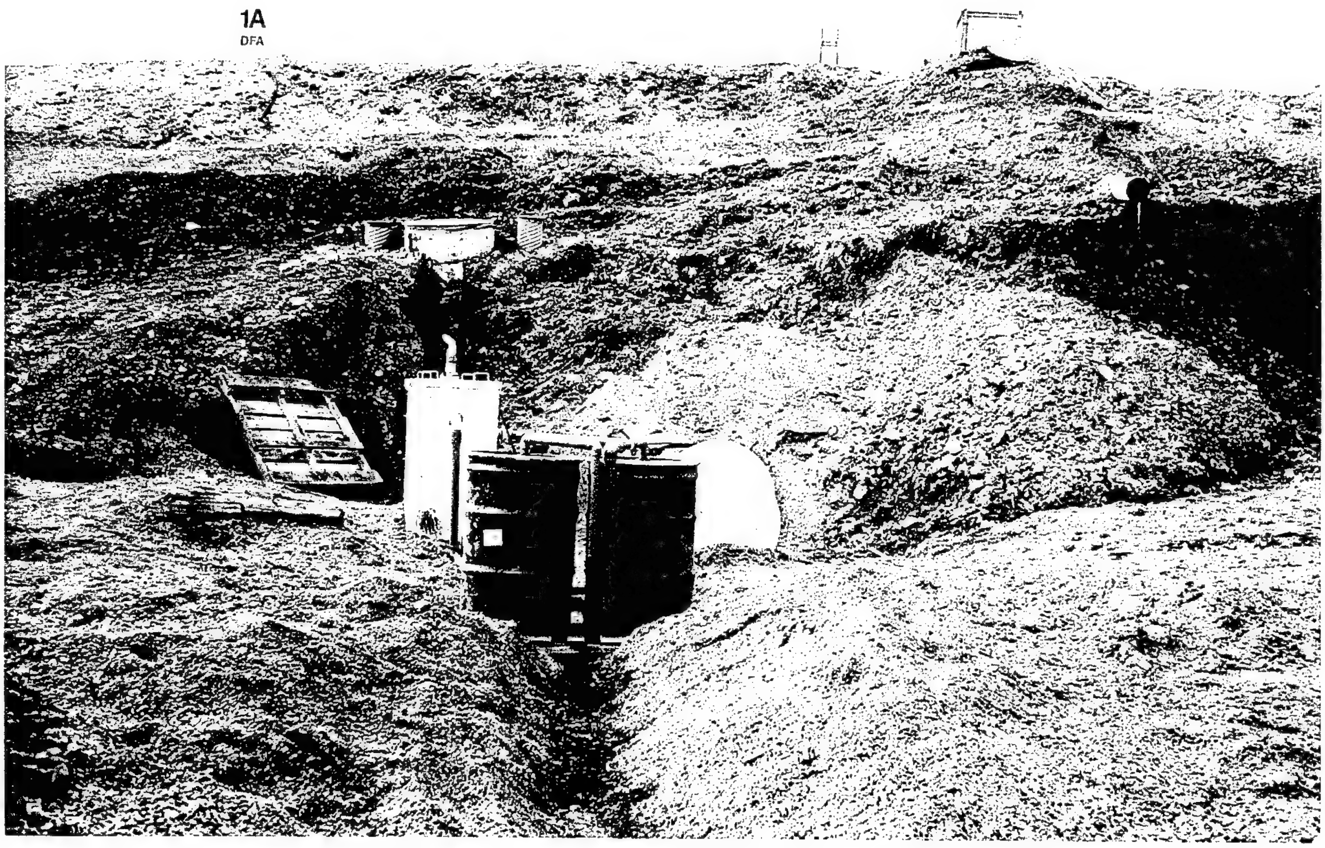


The composite building and a communication antenna ("billboard") of the White Alice Site (SS03) can be see to the left behind the garage. This site, which was deactivated in 1979, is located in the upper camp area in the southwest corner of the station.

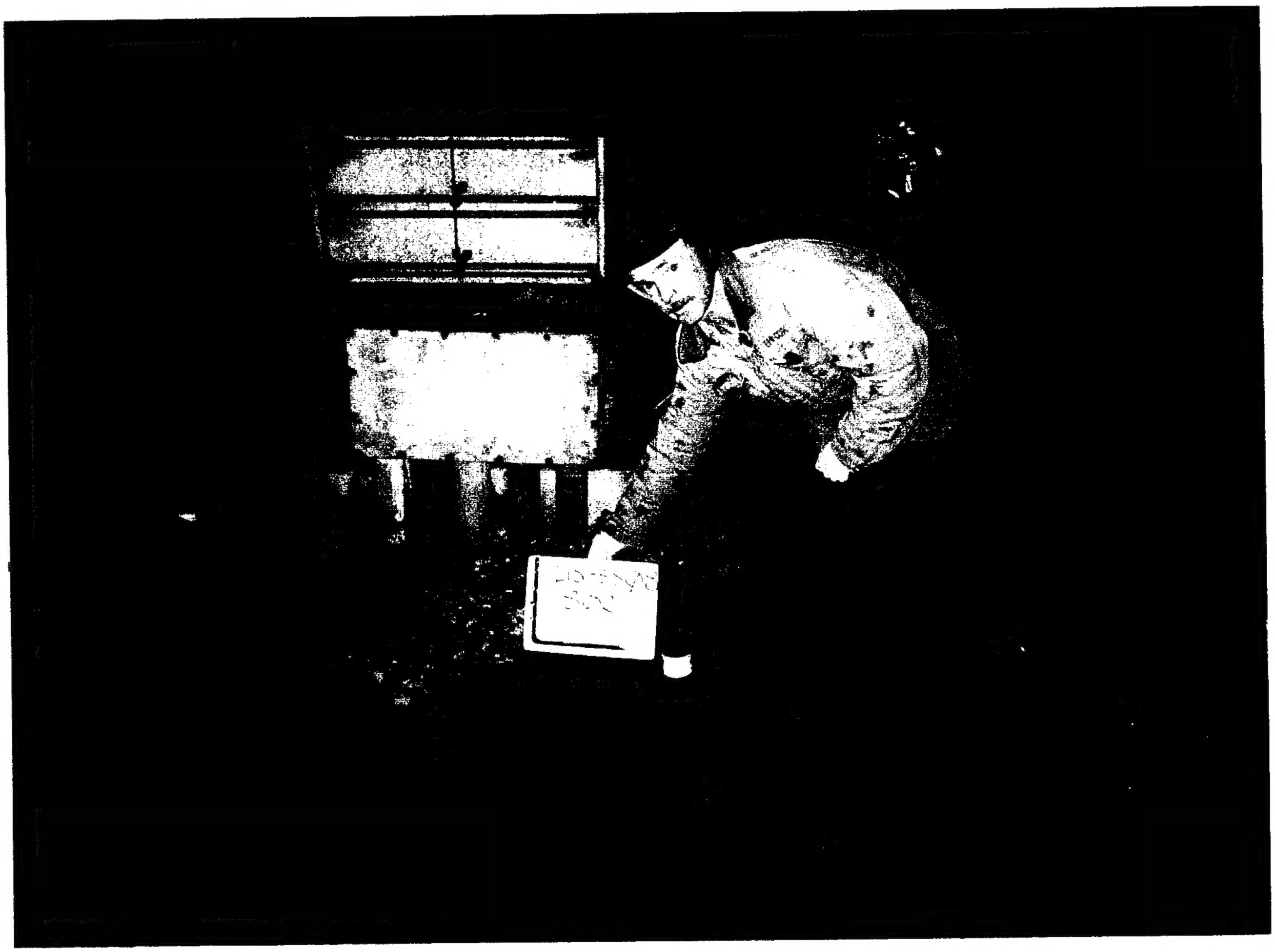
A view to the northeast of the Spill/Leak #3 (ST07) site. Part of the gravel berm surrounding the diesel tanks can be seen to the left.

A view to the south of the Spill/Leak #3 (ST07) site located in the lower camp. Leaks from the diesel tanks (upper left) have migrated to the hillside below the tank. In 1994 an interception trench and water treatment system were constructed at the base of the hillside to collect and treat any diesel migrating from the site.

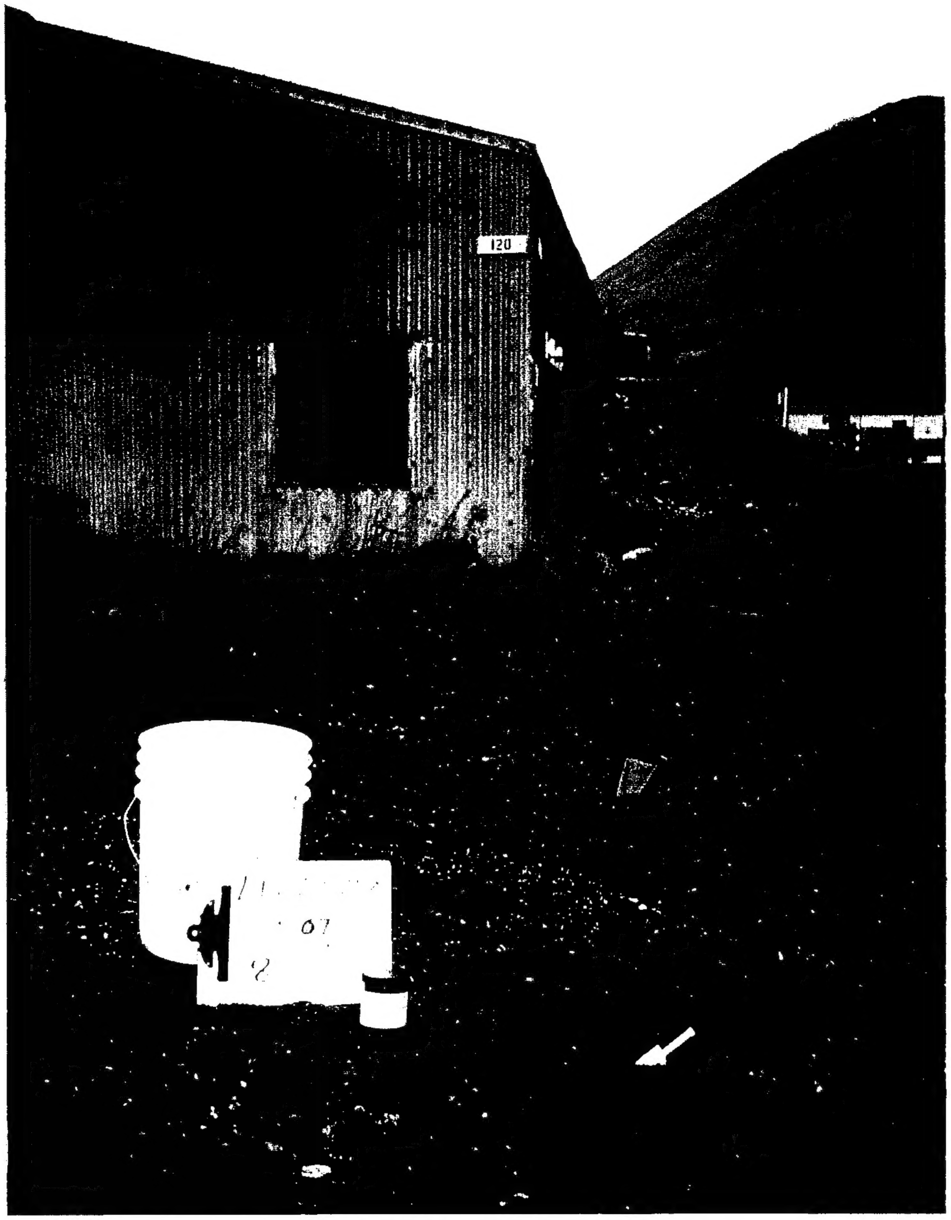
1A
DFA



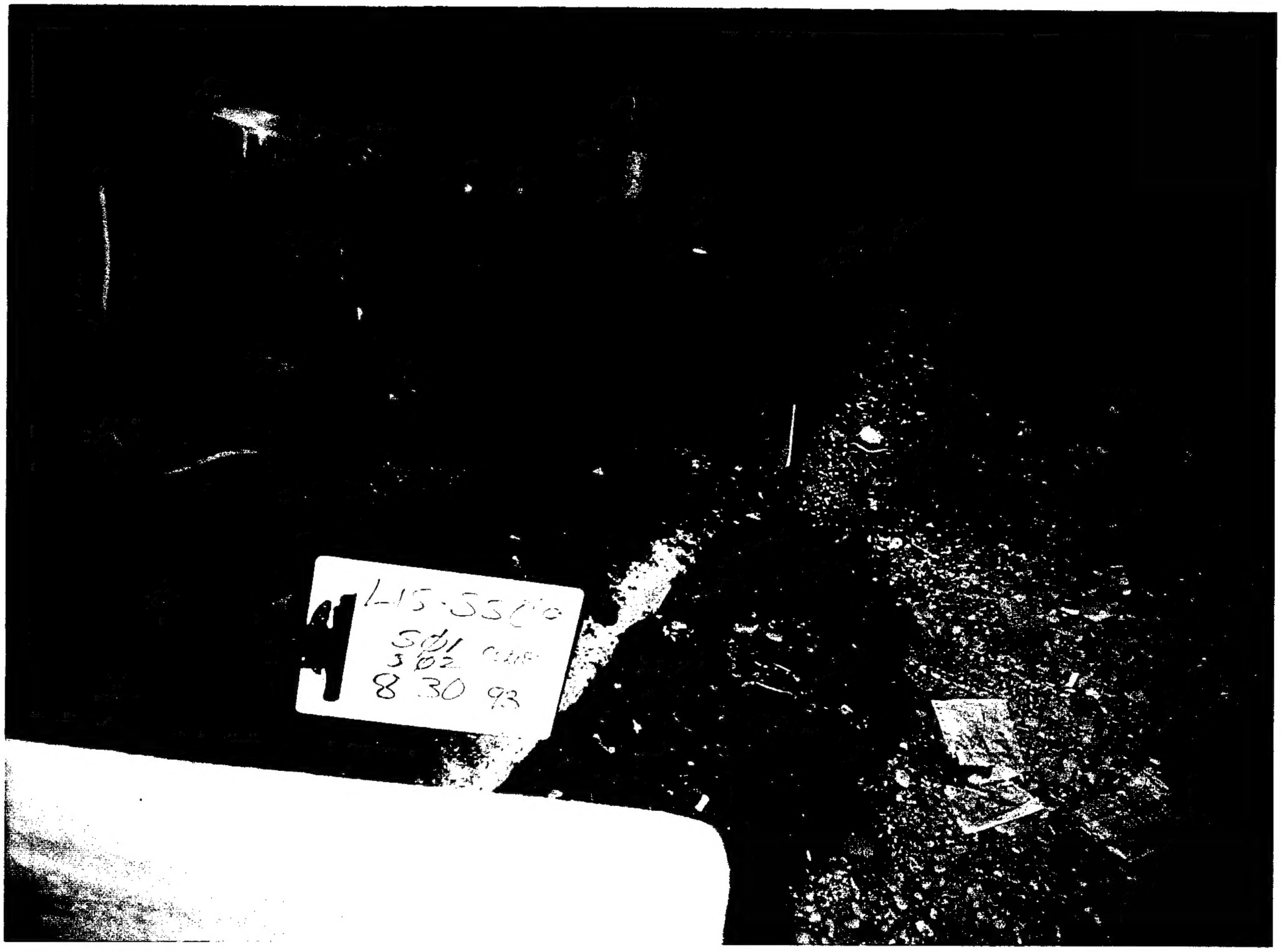
The treatment system at the Spill/Leak #3 (ST07) site consists of an oil/water separator to remove diesel product and carbon adsorption units for treating water collected by the system.



Samples were collected from the soils around the concrete pad at the Upper Camp Transformer Building (SS08) site. This view is of the southeast corner inside the buildings.



A view to the south of the Lower Camp Transformer Buildings (SS09) site, which is located approximately 100 feet northwest of the main building/living quarters at the station.



Staining is apparent on the concrete pad and on the adjacent soil inside the Lower Camp Transformer Buildings (SS09) site.

This standpipe located at Selin Creek is part of the Water Gallery (AOC3). This view is to the northeast.